ANAEROBIC CAPACITY OF JOGGERS OF DIFFERENT AGE

Magdalena **TATARUCH**[1,] Anna **WALASZCZYK**[2,] Janusz **ISKRA**[1.2]

1 .Opole University of Technology, Opole, Poland
2. Academy of Physical Education in Katowice, Katowice, Poland

Key words:
- joggers,
- anaerobic capacity,
- Wingate test,
- age.

Abstract:

The long distance effort is most of all the aerobic effort, but the anaerobic power performance is a important part of final result in continuous runs. In this study we want to look at the amateur long distance running from anaerobic point of view.

The 30-second Wingate test has been used more than other assess the characteristics of anaerobic performance.

In group of 35 amateur endurance runners (“joggers”) we assess level of anaerobic characteristic measured by Wingate test.

In conclusion we observed differences in parameters of Wingate test (PP, HR_{max} and $LA_{max)}$ between groups of “young” and “old” amateur runners.

INTRODUCTION

Physical capacity of man is considered equivalent to its aerobic manifestations. A person who keeps and controls certain pace during prolonged effort of moderate or lower than maximum intensity is usually considered to be physically fit. However, in everyday life there are situations that force the body to perform maximum work in a very short time and then the energy gain is based on anaerobic systems [8, 9, 10].

Apart from a high level of aerobic capacity, anaerobic potential is also of critical importance in any effort that requires stamina and endurance. It is the ability to perform at high intensity, accompanied by rapid changes in the internal environment of the organism; these changes are connected with glycolytic processes leading to considerable local and general acidosis and to significant increase of oxygen debt. Using energy produced through anaerobic processes while performing tasks that require stamina occurs most often when overtaking or at the finish line [4, 12, 13] It was noted that the share of anaerobic processes among people with low level of physical capacity is much greater during physical effort than among those with high level of physical capacity (Nowakowska et al. 1969, quoted in Osiński 2003). Top sportsmen pursuing endurance sports can be also characterized by high levels of anaerobic capacity manifested in the ability to increase the level of oxygen debt, high tolerance to disruption of homeostasis and in the ability to perform work that requires stamina and endurance under conditions of internal environment changes.

Assessment of anaerobic capacity is of particular importance for determining a suitable sport discipline for particular athletes; also, it constitutes a basic research method to verify effectiveness of training methods [3].

For assessment of anaerobic capacity, a test proposed by Bar-Or is often used, also known as the Wingate test [6]. The share of anaerobic processes during an effort subject to test can be up to 80%. This anaerobic test enables one to record the changing dynamics of power as a function of time. The volume of oxygen debt is similar to that achieved after 6-8-

minute-long effort, up to full exhaustion, and the concentration of lactate in the blood 4-5 minutes after the test reaches 13-15 mmol / l among adults [2, 16].

AIM OF THE STUDY

The aim of the study was to assess anaerobic capacity of amateur distance runners (= joggers) of different age.

RESEARCH MATERIAL

The study group consisted of 35 sportsmen (males) regularly participating in recreational endurance runs for amateurs. Apart from participating in numerous mass running events, they also organized cross-country relay events to important religious sites. So far, they have visited such places as the Marian Shrine in Licheń, Poland, or Medjugorje, Bosnia and Herzegovina. A particularly important event for them was a race to the Vatican to meet the Pope John Paul II in the year 2002.

The study group was divided with respect to age into groups of elderly joggers (JOG1), with average age of 50 years, and young joggers (JOG2) with average age of 24.1 years.

All the tests were carried out in collaboration with specialists in the field, and the location of tests were the sport facilities of the Faculty of Physical Education and Physiotherapy at Opole University of Technology, Poland; the endurance tests were carried out in the Function Tests Laboratory (*Pracownia Badań Wydolnościowych*) at the Academy of Physical Education in Katowice, Poland.

The tests were conducted within the framework of the research project approved by the Bioethical Committee of the Chamber of Physicians in Opole.

Table 1. Characteristics of the study group

Group	n	Age (years)	Body height (cm)	Body weight (kg)	BMI
		$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD
Joggers	35	36.6 ± 14.7	175.7 ± 7.6	69.5 ± 10.1	22.52 ± 3.05
JOG1	20	50.0 ± 4.5	172.8 ± 6.9	73.4 ± 10.9	24.50 ± 2.50
JOG2	15.	24.1 ± 5.1	179.1 ± 5.7	69.4 ± 9.4	21.69 ± 3.10

METHODOLOGY

For assessment of anaerobic capacity, the Wingate test was used with a load applied to lower limbs equal to 7.5% of body weight of every person subject to study. All subjects performed a 30-second test with the maximum intensity using Monark ergometer type - Ergomedic 894 E, coupled with a computer software MCE Staniak 5.1. The study was preceded by a 5 minute warm-up with an individually-chosen load; this was done to ensure that the heart rate was in the range of 120 - 140 beats per minute. The following indicators were used in the analysis:

- Anaerobic maximum power (PP) normalized with respect to body weight,
- The rate of decline in power (PD),
- The rate of decline in power in per cents (PD%).

PD and PD% were calculated as the ratio of the difference between the maximum and minimum power.

In the course of the Wingate test, a maximum concentration of lactate in the blood after exercise was measured [mmol/l] [7] along with the rate of decrease in the concentration of lactate (restitution/restoration after an exercise) as well as with the changes in heart rate [beats per minute]. The concentration of lactate in the capillary blood was measured using Lactate Scout analyzer. In order to estimate the rate of restitution after the exercise, the blood was collected in the 4th minute (LA_{max}) and in the 30th minute after the exercise. Based on the changes in the level of lactates in the blood after the exercise and in the 30th minute, the rate of restitution, in per cent, was further calculated.

In order to determine any differences between study groups, the analysis of variance (ANOVA) was used.

RESULTS

The Indicators describing anaerobic capacity in the group of runners is presented in Table 2.

Table 2. Descriptive parameters of anaerobic capacity among joggers (n = 35)

Parameter	$\bar{x}$	SD	÷ Min Max	Skewness	Kurtosis
PP [W / kg]	8.29	1,14	5.60 ÷ 10.26	-0.23	-0.34
PD [w / kg]	2.59	1.02	1.31 ÷ 5.08	0.78	0.19
PD% [%]	31,21	8.59	18.90 ÷ 49.48	0.41	-0.53
HR_{max} [beats / min.]	171.69	13.76	141.00 ÷ 193.00	-0.25	-0.96
LA_{max} [mmol / l]	10.63	3.03	5.70 ÷ 20.40	1.06	1.95
$HR_{4min.}$ [Ud / min.]	98.31	25.06	61.00 ÷ 152.00	0,46	-0.89
$LA_{30min.}$ [Mmol / l]	5.55	1.69	3.10 ÷ 11.40	1.18	**3.01**
$HR_{30min.}$ [beats/ min.]	82.91	18.47	60.00 ÷ 122.00	0.55	-1.02
Restitution ratio [%]	59.07	11.87	35,29 ÷ 83,72	0.27	-0.34

The study revealed that the average PP score of the entire group was 8.29 W / kg and it was comparable to the score recorded for a group of non-practising persons (8.73 W / kg). Also, significant differences were revealed between the groups of younger and elderly joggers. A higher level of maximum anaerobic power (PP) as well as of other indicators describing anaerobic capacity were recorded for younger joggers (JOG2). The higher decrease in heart rate (HR) occurred among elderly joggers JOG1 (46.94%); among younger ones HR decreased within 4 minutes by 37.57%. In this group, one can also calculate the rate of decrease in heart rate (HR) and lactate levels 30 minutes after completion of tests. Among older joggers (JOG1), a faster decrease in heart rate (53.57%) was recorded; among younger joggers (JOG2) the heart rate (HR) after 30 minutes decreased by 49.41%. Lactate levels (LA) decreased rapidly, by 51.53% among younger joggers (JOG2) while among elderly joggers (JOG1) LA fell by 44.07%.

Table 3. Differences between anaerobic parameters reorded for younger and elderly joggers

Parameter	**JOG1**	**JOG2**	**p**
PP (W / kg)	7.58 ± 0.83	9.23 ± 0.74	0.01
PD (W / kg)	2.33 ± 0.79	2.93 ± 1.11	-
PD (%)	30.66 ± 7.10	31.94 ± 10.47	-
Restitution ratio (%)	57.61 ± 13.11	61.01 ± 10.10	-
HR_{max} (beats / min.)	165.65 ± 12.16	179.73 ± 11.74	0.01
HR_{4min} (beats / min.)	87.70 ± 19.31	112.20 ± 25.65	0.01
HR_{30min} (beats / min.)	76.90 ± 15.51	90.93 ± 19.52	0.05
LA_{max} (mmol / l)	9.28 ± 2.39	12.44 ± 2.89	0.01
LA_{30min} (mmol / l)	5.19 ± 1.48	6.03 ± 1.87	-

The analysis of variance for the maximum anaerobic power revealed statistically significant differences between elderly joggers (JOG 1) and the remaining study groups. Among younger joggers (JOG2), this parameter differed at the level of statistical significance between the group JOG1 and non-practising students at Opole University of Technology (PO).

The differences with respect to rate of decline in power (in per cent) were found to be statistically significant between the groups of joggers and the remaining groups. No statistically significant difference was observed between the groups JOG1 and JOG2.

The analysis of variance with respect to HR_{max} and HR in the 4th minute for all study groups showed statistically significant differences between older joggers (JOG1) and the remaining groups. In contrast, the level of the heart rate measured in the 30th minute after the test was different; the difference between the groups JOG1 and JOG2 was found to be statistically significant.

Statistically significant differences within the group of younger and elderly joggers were also observed with respect to the maximum concentration of lactate.

DISCUSSION

The ability to increase oxygen debt and the high-level of tolerance to homeostasis disorder are typical not only of those sportsmen who pursue disciplines of short duration; it should be noted that these characteristics are also, and to a large degree, typical of those sport disciplines that require stamina and endurance. This is confirmed by the study conducted by Hollman (1972, quoted in Raczek 1987), who refers to athletes who completed an 800-meter race and who reported to have the lactate concentration in excess of 20 mmol / l; the same was the case of athletes who completed a 5,000-metres race - in their case the said parameter exceeded 15 mmol/l .

In the case of efforts that require stamina and endurance, the ability to benefit from anaerobic processes can contribute to better results. However, the basis for achieving good results in endurance sports is a sufficiently high level of aerobic function/capacity. Athletes of a high-level of aerobic capacity may also manifest greater predisposition to perform maximum intensity efforts that require the use of anaerobic energy processes [12].

One can also note a significant difference in the levels of maximum power among groups under scrutiny, notably as compared with the top long-distance runners. However, comparison of these results to the level of maximum power among medium- and long-distance runners, who reached the PP in the range 7.97-11.95 W / kg, shows that only a group of elderly joggers (JOG1) did not reach the PP score within the said range.

An overview of results of research on anaerobic capacity of athletes pursuing various sports disciplines and recorded in the Wingate test shows that medium-distance runners achieved maximum power of 10 W / kg; the corresponding parameter for long-distance runners was 11.4 W / kg [5].

Assessment of anaerobic capacity across groups of varying degrees of running activity, carried out using the Wingate test showed that people with high-level of physical fitness (physical education students - WF1 and WF2 and younger joggers - JOG2) have a much greater maximum anaerobic power. The lowest values of the maximum power were found in the group of elderly joggers (JOG1) and among those persons who do not pursue any running activities - PO.

A division of joggers into an elderly (JOG1), with average age = 50 years, and younger ones (JOG2, average age = 24 years), revealed considerable differences with respect to anaerobic capacity across men of different age. The data show that despite a high-level of physical activity in a group of elderly joggers (JOG1), their level of maximum anaerobic power is at its lowest, as compared with other groups under study. The studies conducted by Adach (2002) revealed that anaerobic power decreases significantly with age. A maximum anaerobic power in a group of 60-year-old males is lower by about 30% as compared with a group of students (20-25 years) and men of 40 years of age. A decrease in the maximum power level with age results, naturally, from reduced ability of elderly people to perform cyclic movements with a maximum intensity, requiring interaction of different muscle groups (Kent-Brown and Alexander 1999, quoted in Adach 2002).

Our studies showed that the level of maximum anaerobic power in a group of elderly joggers (50-year-old and older) is lower by only 20% than the results achieved by physical education students. Such a small difference may be due to active lifestyle of men in the JOG1 group.

An interesting finding refers to another parameter, namely the percentage decrease in heart rate after maximum effort; it shows the rate of regeneration of the body associated with smooth and fast restitution process. The largest percentage decrease in HR was observed among elderly joggers JOG1 (46.94%) as well as among younger joggers JOG2 (37.57%). Fast post-exercise regeneration may be caused by "resistance" of the body to disruption of homeostasis, a benefit achieved through daily endurance workouts.

An important factor, which also refers to the level of anaerobic capacity, is the rate of decline in power PD%. The values of this index show statistically significant differences between joggers and the remaining groups under study (Table 2).

In the group of joggers under study, a number of persons who are 30 years old or older is the highest, likewise in the group of the best in the world. A number of participants in marathons increases with age, reaching its highest value for the 28-year-olds (11.9%). Figure 25 also shows that from among the top marathoners in the world one can select a large group of runners above 30 years of age [15].

A significant number of participants, who are 40 years old or older, in mass running events further confirms that for the elderly persons running constitutes one of the most popular "healthy" forms of physical activity.

CONCLUSIONS

The study on anaerobic capacity of joggers revealed significant differences with respect to selected parameters (PP, HR_{max}, LA_{max}) recorded immediately after the tests.

These parameters, in the longer period of post-exercise restitution (30 minutes after the test, in particular) did not differ in a statistically significant way.

Although the results obtained by joggers are similar regardless of their age (more specific data were presented in [14]), anaerobic capacity parameters for both groups are varied.

The results of the analysis suggest that the structure of the physical function of runners may vary, and it is irrespective of the fact that amateur jogging is not constrained by any age limit.

REFERENCES

1. Adach Z. (2002) *Charakterystyka cech siłowo-szybkościowych wybranych grup mięśniowych u mężczyzn w różnym wieku a poziom wydolności anaerobowej-fosfagenowej*. AWF, Poznań.
2. Astrand P.O. Rodahl R (1986) *Texbook of work physiology*. MC Grow – Hill Book Company, New York.
3. Braksator W., Mamcarz A., Dłużniewski M. (2007) *Kardiologia sportowa*. Via Medica, Gdańsk.
4. Costill D.L., Wilmore J.H. (1994) Physiology of Sport and Exercise. *Human Kinetics*, Champaign, Illinois.
5. Gabryś T. (2000) *Wydolność beztlenowa sportowców*. AWF, Katowice.
6. Inbar O., Bar-Or O.,Sinner J.S. 1996. *The Wingate Anaerobic Test*. Human Kinetics, Champaign, IL.

7. Jaskólski A. (2002) *Podstawy fizjologii wysiłku fizycznego*, AWF, Wrocław.
8. Kozłowski S., Nazar K. (1984) Metaboliczne podłoże wysiłków wytrzymałościowych. *Fizjologiczne podstawy treningu sportowego – wytrzymałość*. AWF, Warszawa.
9. Kozłowski S., Nazar K. (1999) *Wprowadzenie do fizjologii klinicznej*. PZWL, Warszawa.
10. Norkowski H., Kuder A., Zghidi M. (2007) Moc anaerobowa młodych kobiet o różnej aktywności ruchowej. *Kierunki doskonalenia treningu i walki sportowej – diagnostyka, Tom 4,* AWF, Warszawa.
11. Osiński W. (2003) *Antropomotoryka.* AWF, Poznań.
12. Raczek J. (1987) *Doskonalenie wytrzymałości w procesie treningu sportowego*. Instytut Sportu, Warszawa.
13. Szmatlan-Gabryś U. (2012) Trening wytrzymałości: optymalizacja metod i obciążeń treningowych. 4Sportlab Warszawa.
14. Tataruch M. 2013. *Rekreacyjne biegi wytrzymałościowe. Wieloaspektowa analiza empiryczna*. AWF, Katowice.
15. Tataruch M. Łukonowa-Jakubowska A. (2006) Age of sport mastery in marathon race for men and women between 1986 and 2005. *Movement and Health*. Politechnika Opolska, Głuchołazy, pp. 188 – 194.
16. Waśkiewicz Z. (2002) *Wpływ wysiłków anaerobowych na wybrane aspekty koordynacji motorycznej.* AWF, Katowice.