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Physiological symptoms of physical adaptation to various exertions following short-lasting training period in elite professional boxer. A case study

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Summary

Introduction. The purpose of this study was to detect symptoms of adaptation to endurance and maximal, exhausting exercises attained after short-lasting training period at mild altitude in elite professional boxer. The state of adaptation was determined based on end-exercise blood hormones and lactate levels.

Material and methods. Professional boxer was examined at the end of 2-month detraining period. He underwent incremental exhaustive test (IET) on motorized treadmill, and two weeks after that examination he started training at mild altitude (1000 m). Four days after arrival to training camp located on 1000 m above see level he was subjected to the first trial opening the series of five exertions undergone on separated days. These exertions were separated by 3-day intermissions and were undergone in the order as follows: two repeated runs (2 x 400 m) with 30 second intermission between bouts, uphill running and walking (URW) with voluntary speed on a tourist trail which elevation was of 960 m (start at 1000 m, end at 1960 m above sea level) with distance to cover of 5.5 km (1st examination), resistance training session, repeated three runs (3 x 400 m) with 30 s intermissions and finally URW on the same trail as previously (2nd examination). These exercises were undergone at the same daytime (9:30-12:00 am) Capillary blood were sampled before and after laboratory test and field trials to measure levels of serum cortisol, testosterone, growth hormone, prolactin and blood lactate.

Results. The main symptoms of adaptation developing during training period were lower cortisol and prolactin responses to exertion occurring with time of training period.

Conclusions. The observed changes of post-exercise blood indices indicated rapid improvement of physical adaptation to the exertions following short-lasting training period.

Introduction

There are different requirements for physical fitness in amateur and professional boxing. Amateur boxing match lasts 3 rounds (3 x 3 min) while professional one is much more longer, from 8 to 12 rounds. In addition, professional boxers do not use helmets, therefore they are exposed to head injury and knockout in a greater extent than amateur ones. Competition in professional boxing is limited to play one struggle, and the amateur boxing tournament lasts few consecutive days (heats, semi- finals and finals), except the case, that the first contest loss eliminates a player from further games. For these reasons, after longer period without training activity (detraining), professional boxer prepares to his fight over longer time, and during it he has to improve endurance at the beginning, and afterwards strength and boxing skills. At any sport event retraining followed by detraining brings about general biological adaptation to single exertion among athletes. The symptoms of that adaptation may be expressed as improvement of physical possibility for instance: longer time to exhaustion when intensity exertion is of stable or if it grows up, higher velocity of movement and shorter running time to cover the same distance, higher VO_{2max} and peak power output [1-3]. These mentioned reports focused on the potent beneficial effects of mild altitude hypoxia since altitude training is often recommended for athletes as being more effective than that carried out in normobaric conditions [4,5].

Another recent findings showed, that for endurance-trained athletes strength training is an important factor enhancing effects of endurance training, and that is independent of changes in maximal oxygen uptake. The mechanism of that phenomenon is that muscle strength development improve economy of working muscles, thus, strength exercises are recommended for even for distance runners, road cyclists, cross-country skiers [6-9].

Important training effect in boxers is improvement of so-called psychomotor fatigue threshold (PFT) determined by assessment of choice reaction time. It known, that choice reaction time, is a parameter which may be considered partly as a predictor of success during boxing tournament, and its value increases with induced by exertion fatigue and/or rise of blood lactate. Recently, Chmura and Nazar [10] reported shifting of PTF towards higher running, that was occurred after training period. There is, however, risk of development of fatigue when durations of recovery periods are inadequate to training loads or its intensity. That state named overreaching lead to growing down of athletic performance [11], thus, too much exercises may deteriorate physical state exercising athletes. This study aimed to examine short-term effects of re-training at mild altitude (1000 m) on development of selected physical parameters and changes in some blood indices induced by various field exertions.

Material and methods

Professional boxer was studied at the end of 2-month detraining period. During laboratory study he underwent incremental exhaustive test (IET) on treadmill until refusal, and two weeks following that study he started training on a camp located at mild altitude (1000 m a.s.l.) where he housed and trained. Some endurance trainings like uphill running and walking ended at higher altitude (above 1900 m a.s.l.). Two types of trainings sessions were performed alternately, endurance and strength-velocity exercises. Four days after arrival to training camp and moderate activity he has been subjected to the field trials to evaluate development of physical fitness and state of physiological adaptation. The series of five exertions undergone on separated days. These exertions were separated by 3-day intermissions, and were undergone in the order as follows: two repeated runs (2 x 400 m) with 30 second intermission between bouts, uphill running and walking (URW) with voluntary speed on a tourist trail of elevation of 960 m (start at 1000, end at 1960 m above sea level) and distance of 5.5 km (1st examination), resistance training session, repeated three runs (3 x 400 m) with 30 s intermissions and second URW on the same trail as previously (2nd examination). All examined effort were undergone at the similar daytime (9:30-12:00 am). Capillary blood were sampled before and after trials to measure levels of serum cortisol, testosterone, growth hormone, prolactin and blood lactate, determined with commercial kits (IBL-Germany). The protocol of this study was approved by the local Ethical Commission at Institute of Sport. Moreover, the subject gave his informed consent to participate in the study after informing about the meaning of this study as well as benefits and potent risk of blood sampling and of efforts.

Results

Results the hormonal and metabolic indices are displayed in Table 1, 2 and 3.

The results revealed clear symptoms of hormonal adaptation which was developing with time of training period.

Incremental exhaustive test. Elevation of C, T, and PRL over the period between morning and pre-test state revealed strong anticipation (psychological arousal) of the maximal efforts. Peaks of C were shifted toward +30 minute of recovery, while peak of T, GH and PRL were attained earlier, at +3 minute of recovery.

Repeated bouts (2 x 400 m and 3 x 400 m). Mean C calculated from 3 time points, pre-run, +3 and +30 minute was considerable lower (446 nmol/L) during the second run test (3 x 400 m) in comparison to that during the first one (616 nmol/L). It is worth to emphasis, that C increased (by 24%) at +30 minute of recovery after 1st run-test, while the second one, longer by one lap (400 m), did not induced any changes in C. Likewise, blunted prolactin response was noticed to the second run-test. Interestingly, when considerable rise of prolactin was recorded, as a proof of stimulated pituitary, the other pituitary hormone, GH did responded to the exertions very weakly. End-exertions lactate and rate of its normalization over recovery was the same in both terms. During first run-test (2 x 400 m) the the first time trial was of 1 min 23 s the second was of 1 min 25 s. During the second run-test (3x

Tab. 1. Changes in the levels of cortisol (C) and testosterone (T) in nmol/L, and growth hormone (GH) and prolactin (PRL) in ng/ml in the morning (8:00) and during run on treadmil (IET) in elite boxers

Variable	8:00	-10 min before	+3 min after	+30 min after
C	560	891	806	1148
T	15.5	17.6	24.4	20.6
GH	0.2	0.3	1.6	0.8
PRL	11.8	15.2	25.2	14.9

Tab. 2. Changes in serum growth hormone (GH) and prolactin (PRL) levels in ng/ml following various exertions in examined boxer

Type of exertion	-10 min before exertion		+3 min post exertion		+30 min post exertion	
	GH	PRL	GH	PRL	GH	PRL
Run 2 x 400 m 1st examination	0.2	7.3	0.8	19.7	0.8	14.2
Uphill run 1st examination	0.3	12.4	2.2	10.0	0.6	9.8
Resistance training (2 h)	0.2	8.3	2.2	3.9	-	-
Uphill run 2nd examination	0.5	10.5	3.6	9.9	0.8	8.3
Run 3 x 400 m 2nd examination	0.3	7.4	1.5	15.7	1.3	10.2

Tab. 3. Changes in serum cortisol (C) and testosterone (T) levels in nmol/L and blood lactate levels in mmol/L following various exertions in examined boxer

Type of exertion	-10 min before exertion			+3 min post exertion			+30 min post exertion		
	C	T	LA	C	T	LA	C	T	LA
Run 2 x 400 m 1st exam	579	22.9	1.3	552	26.0	13.2	717	25.0	8.4
Uphill run 1st exam	634	24.3	1.2	745	16.7	2.6	798	14.4	1.2
Resistance training (2 h)	552	17.4	1.9	431	18.4	2.7	-	-	-
Uphill run 2nd exam	510	24.1	1.2	607	19.4	2.9	652	18.9	1.2
Run 3 x 400 m 2nd exam	497	23.9	1.1	428	24.3	13.1	414	20.1	7.1

400) the tree successive laps were covered at 1 min 26 s, 1min 28 s, and 1 min 40 s respectively.

Uphill runs. The pattern behavior of C during uphill runs as a symptom of adaptation was similar to that mentioned above regarding C responses to run-tests. During 1st examination mean C (726 nmol/L) was higher compared to cortisolism during 2nd task (590 nmol/L). C progressively rose throughout recovery in both terms. PRL levels during both examinations were alike, and its absolute rises were lower than after shorter but of higher intensity run-tests. The low level (below lactate threshold) of LA post-uphill tests indicated on aerobic types of exercise. The distance of the first uphill run was covered at 1 h and 48 min, while time of the second one was shorter by 7 minutes. The weather during these uphill test were alike.

Resistance training was not considerable stimulus for hormonal systems and glycolysis.

Taking into account all samples (n=14) it was found that T correlated positively with PRL (r=0.621*, $p<0.05$) and negatively with HGH (r=-0.604*, $p<0.05$).

On the camp pre-efforts levels of hormones fluctuated, and their mean levels: C= 554±55nmol/L, T= 22.6± 2.9 nmol/L and PRL 9.2±2.2 ng/ml were lower, but T=22.6±2.9 nmol/L was higher from those prior to laboratory test.

Discussion

Our study revealed that two type of markers adaptation: shorter time trials, and lower hormonal responses. In our study the levels stress-hormones (C and PRL) recorded prior to laboratory effort were higher than those recorded at the same conditions, i.e. on the training camp before efforts. It is hard to elicit, whether that differences resulted in stronger anticipatory stress prior to laboratory run, or due to few-day altitude training which reduced sensitivity of those hormones levels at rest as well after efforts. C and PRL are considered as markers of psychological and physical stress, one may assume laboratory trial was more psychically and physically stressful than the trials performed during camp. Moreover mild altitude together with four-day retraining period probably reduced high physiological sensitivity to various type of challenge, but contribution each of these two factors to recorded adaptation will be discussed later.

There are numerous scientific proofs for desensitization of hormonal systems after repeated physical stimuli like training sessions. 2-week training period in the same mountain camp followed by 1-month detraining brought about dropped adrenal function expressed by lower morning, pre-Wingate test and effort C responses in elite female judokas [12]. In that study mean power output and end-exercise LA did not change after training but rate of lactate disappearance over recovery was higher (4.8 vs 6.2 mmol/L at + 30 min). The similar dropped in resting C was observed in competitors taking part in exhausting prolonged strain, a 6-day Nordic -ski race, however that change direction suggests rather development of chronic fatigue rather than physical adaptation [13]. Contrary to mentioned results the other authors showed rise of resting

C at the end of 5-weeks altitude training period in triathletes, however, these subjects housed and trained longer and at higher altitude (1860 m) [14]. Similar rise of T was found within 48 h of arrival at altitude of 2000 m while C elevated gradually from the beginning to the end of altitude exposure [15] in non-exercising subjects. The higher T at altitude (1650 m) than at sea level was found Vasankari [16]. Also PRL is the hormone, which elevated from initial values of 5.8 to 9.2 ng/ml in rest condition, in response to exposure on stronger hypoxia induced by higher (3500 m) altitude higher [17]. It seems that beneficial effect of altitude training on the fitness parameters appears only when subjects train and live at altitude. That was confirmed by Engfred et al. [18], who reported, that training sessions performed at hypoxia simulating 2500 m altitude (hypobaric chamber) by group housed at normoxia induced the same effects as those in the control group exercising and living in normoxia.

Examined boxer realized type of exercises similar to those as judokas [12] on the same mountain camp (Zakopane). That activity was predominantly aerobic (endurance-oriented) with strength exercises. We may assume, that demonstrated improvement of adaptation in examined boxer was induced rather due to optimal composition of exercises, but lower extent from environmental condition. Hypoxia which corresponds the altitude level of 1000 m together with short-term time exposure seems to be insufficient stimulus for development hematological changes like rise of hemoglobin mass and red cell volume, that occurred at altitude level of 2000-2500 m. Thus, we may excluded potent hematological changes as a contributor of fitness improvement in examined boxer.

Conclusions

Improvement of physical adaptation following short-term training in professional boxer expressed itself by shorter time trials and blunted serum cortisol and prolactin responses.

References

1. Morton JP, Cable NT. Effects of intermittent hypoxic training on aerobic and anaerobic performance. Ergonomics 2005; 48: 1535-1548.
2. Roels B, Bentley DJ, Coste O, Mercier J, Millet GP. Effects of intermittent hypoxic training on cycling performance in well-trained athletes. Eur J Appl Physiol 2007; 101: 359-368.
3. Debevec T, Amon M, Keramidas ME, Kounalakis SN, Pisot R, Mekjavic IB. Normoxic and hypoxic performance following 4 weeks of normobaric hypoxic training. Aviat Space Environ Med 2010; 81: 387-393.
4. Wilbur RL. Live high + train low: thinking in terms of an optimal hypoxic dose. Int J Sports Physiol Perform 2007; 2: 223-238.
5. Friedmann-Bette B. Classical altitude training. Scand J Med Sci Sports 2008; 18 (suppl. 1): 11-20.
6. Hoff J, Helgerud J, Wisleff U. Maximal strength training improves work economy in trained female cross-country skiers. Med Sci Sports Exerc 1999; 31: 870-877.
7. Østerás H, Helgerud J, Hoff J. Maximal strength-training effects on force-velocity and force-power relationships explain increases in aerobic performance in humans. Eur J Appl Physiol 2002; 88: 255-263.
8. Støren O, Helgerud J, Støa EM, Hoff J. Maximal strength training improves running economy in distance runners. Med Sci Sports Exerc 2008; 40: 1087-1092.
9. Yamamoto LM, Klau JF, Casa DJ, Kraemer WJ, Armstrong LE, Maresh CM. The effects of resistance training on road cycling performance among highly trained cyclists: a systematic review. J Strength Cond Res 2010; 24: 560-566.
10. Chmura J, Nazar K. Parallel changes in the onset of blood lactate accumulation (OBLA) and threshold of psychomotor performance deterioration during incremental exercise after training in athletes. Int J Psychophysiol 2010; 75: 287-290.
11. Couts AJ, Reaburn P, Piva TJ, Rowsell GJ. Monitoring for overreaching in rugby players. Eur J Appl Physiol 2007; 99: 313-324.
12. Obmiński Z, Stupnicki R, Borkowski L, Lerczak K, Błach W. Effect of altitude training on glucocorticoid response to 30 s supramaximal exercise (Wingate test) in female judoists. Biol Sports 1996; 13: 273-278.
13. Fellman N, Bedu M, Boduet G et al. Inter-relationships between pituitary-adrenal hormones and catecholamines during a 6-day Nordic ski race. Eur J Appl Physiol 1992; 64: 258-265.
14. Wilber RL, Drake SD, Hesson JL et al. Effect of altitude training on serum creatine kinaze activity and serum cortisol concentration in triatheletes. Eur J Appl Physiol 2000; 81: 140-147.
15. Humpeler E, Skrabal F, Bartsch G. Influence of exposure to moderate altitude on plasma concentration of cortisol, aldosterone, rennin, testosterone and gonadotropins. Eur J Appl Physiol 1980; 45: 167-176.
16. Vasankari TJ, Rusko H, Kujala UM, Huhtaniemi IT. The effect of ski training AT altitude and racing on pituitary, adrenal and testicular function in men. Eur J Appl Physiol 1993; 66: 221-225.
17. Sawhney RC, Chhabra PC, Malhotra AS, Singh T, Riar SS, Rai RM. Hormone profiles at high altitude. Andrologia 1985; 17: 178-184.
18. Engfred K, Kjaer M, Secher NH et al. Hypoxia and training-induced adaptation of hormonal responses to exercise in humans. Eur J Appl Physiol 1994; 68: 303-309.
19. Heinicke K, Heinicke I, Schmidt W, Wolfarth B. A three-week traditional altitude training increases hemoglobin mass and red cell volume in elite biathlon athletes. Int J Sports Med 2005; 26: 350-355.
20. Wehrlin JP, Zuest P, Hallén J, Marti B. Live high-train low for 24 days increases hemoglobin mass and red cell volume in elite endurance athletes. J Appl Physiol 2006; 100: 1938-1945.

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