World Journal of Sport Sciences 5 (2): 101-106, 2011
ISSN 2078-4724

Relationship Between Maximum-Intensity Training with the Gene Expression of the Female Players of the Egypt National Karate Team

[1]Essam Abdel Hamead Hassan, [2]Basmat Mohamed Aly and [1]Mohamed Mohamed Aly

[1]Department of Sport Health Science, Faculty of Physical Education, Minia University, Egypt
[2]Department of Sport Training, Faculty of Physical Education, Minia University, Egypt

Abstract: This study aimed to identify the impact of training with maximum intensity on the gene expression and its relationship with some physiological and physical variables. Twelve female players of the Egyptian National Karate Team performed a Karate training module with maximum intensity. The statistical analysis of the data indicated an increase in the concentration of RNA after the performance of the module. There was negative correlation with statistical significance between the concentration of RNA and the rate of lactic acid, whereas the concentration of RNA had positive correlation with the physiological and physical variables under investigation. The statistical analysis showed also that the players with high concentration of RNA have larger values of the physical variables under investigation than those of the players with low RNA concentration. The authors concluded that the gene expression responds to training with maximum intensity and that adaptation to training with maximum promotes the concentration of RNA and hence the ability to resist fatigue.

Key words: RNA % Lactic Acid % Anaerobic Power

INTRODUCTION

The science of sports training is regarded as a melting pot of various sciences and many different philosophies and directions in the development of sport sciences which has been associated with many theories of sports training. Performance in sport and fitness-related activities is the result of many interacting factors, which can be grouped broadly under environmental and genetic categories. Environmental factors include training and preparation, diet, equipment, weather-related conditions and many others. Genetic factors are also known to contribute to sport performance. Genetic variation contributes to individual differences in psychological, behavioral, morphological and physiological traits. Moreover, genetic variation among people influences how individuals respond to training [1, 2].

From the biological point of view, sports training is the process of improving the body's systems to perform different types of physical load, which eventually lead to changes in internal organs. These changes result in an increased efficiency of the body to get used to the requirements appropriate to the nature and type of activity, which induce different Exercise training elicits a number of adaptive changes in skeletal muscle that result in an improved Muscle work efficiency [3, 4]. The problem of fatigue is considered as the biggest problems faced by athletes during athletic performance as well as the most important performance constraints. The ultimate goal of the process of sports training is to reach the optimal performance of the players throughout the competitive performance of a play without early fatigue or to try to delay its appearance for the longest possible period.

The accumulation of lactic acid is the most apparent manifestations of fatigue during athletic performance, where during high-intensity exercise, large amounts of lactate and H+ can be produced in skeletal muscle and the resulting accumulation of lactate and lowering of pH in the muscle can impair the ability of the muscle to maintain force [5]. The capacity to transport lactate and H+ out of the muscle fibers may, therefore, be expected to affect the ability to perform sustained high-intensity exercise. In addition, the capacity of skeletal muscle to take up lactate constitutes an important step in the redistribution and reuse of lactate after high-intensity exercise [6].

Corresponding Author: Essam Abdel Hamead Hassan, Department of Sport Health Science, Faculty of Physical Education, Minia University, Egypt.

Karate is one of anaerobic sports with of maximum intensity that depends on the anaerobic energy for producing energy through the lactic acid. It is also a combat competitive sports marked with variable positions that appear during sudden conditions, which require different and various reactions such as the use of attack and defense tactics in addition to the movements of the feet. All these methods are non-recurrent predominated with dynamic works in most seconds of the match keeping fast performance [7]. Genetics and the genetic study are fast-evolving sciences; genes play an important role in the field of physical education and may be more important than training in the interpretation of differences in the performance of players.

Gene expression is the process by which information from a gene is used in the synthesis of a functional gene product. These products are often proteins, but in non-protein coding genes such as rRNA genes or tRNA genes, the product is a functional RNA. The process of gene expression is used by all known life - eukaryotes (including multicellular organisms), prokaryotes (bacteria and archaea) and viruses - to generate the macromolecular machinery for life [8, 9].

Gene expression occurs in two major stages. The first is transcription. In this process, the gene is copied to produce an RNA molecule (a primary transcript) with essentially the same sequence as the gene. The second stage is protein synthesis. This stage is also known as translation and is so called [10].

Differences in muscle phenotype and subsequent function occur by activating and/or repressing different subsets of genes. A rate-limiting step for protein synthesis in response to exercise is the level of transcription and the quantity of mRNA abundance [11], with the level of mRNA determined by the rates of mRNA synthesis and decay. New steady-state protein synthesis via chronic and load-specific stimuli can optimize muscle tissue for such diverse physiological functions as strength or endurance capabilities [12].

In this paper, we identify the impact of training with maximum intensity on the gene expression and investigate its relationship with some physiological and physical variables. The physiological variables are the lactic acid and anaerobic capacity, while the physical variables are related to the physical performance in karate; namely, the racist beard speed and beard power through the performance of some kicks and punches.

MATERIALS AND METHODS

Research Sample: Twelve female players of the Egyptian National Karate Team with age 20±2year, length 161±4cm, weight 63.5±5Kg and training age 16±2 years were selected for the present study. The statistics of these players are listed in Table 1.

Table 1 shows that the torsion coefficient of the players ranges between -0.18 and 0.15. That is, it is limited between ±3 which indicates that it lies within the normal curve and thus the sample is distributed normally and is homogeneous.

Methodology: The authors used the descriptive method in this paper.

Instrumentation: Blood samples (5 mm^3) were withdrawn from the players and placed in tubes with EDTA material to prevent blood clotting. The players and made a training module with a maximum intensity of duration90 minutes.

Table 1: Arithmetic average, median, standard deviation and skewness coefficient of the variables: (age, length, weight and training age)

Variable	Arithmetic average	Median	Standard deviation	Skewness coefficient
Age	21.67	22	1.3	0.15
Height	161	161.5	2.89	0.16-
Weight	63.75	63.5	3.67	0.05-
Training years	13.17	13	1.75	0.18-

Table 2: Time of performing punches and kicks of speed and force endurance

Punches and kicks	Period of speed endurance	Period of strength endurance
Kizami Zuki	20 s	40 s
Gyaku Zuki	20 s	40 s
Mawashi Geri	25 s	45 s
Kizami Mawashi Geri	25 s	45 s
Ora Mawashi Geri	25 s	45 s
Kizami Ora Mawashi Geri	25 s	45 s

The module included a series of physical exercises and skills. The intensity of the training was codified using the pulse rate. The authors used the equation the maximum pulse (220 - chronological age). The pulsing rate of the training then reached (160 ~ 180 pulse / s). After the end of the module directly another blood sample was taken. This was on Wednesday, 18/03/2009. On the following day (Thursday, 19/3/2009) the physical tests were carried out, which are anaerobic capacity using the test of vertical jump from stability, the calculation of scores using the guide for Lewis and the tests of the speed endurance and strength endurance which were measured by performing the largest number of punches and kicks in a specified time scale, as given in Table 2. The RNA concentration of the players (the research sample) was determined using the method of PCR (polymerase chain reaction). The lactic acid was measured by means of the Accusport apparatus.

Analysis: The data were analyzed using the both Wilcoxon and Mann-Whiteny nonparametric methods to measure the significant differences between the averages and the Spearman correlation coefficient. The level of significance was measured as 0.05. The statistical program SPSS version12 was used for the present calculations.

RESULTS AND DISCUSSION

The obtained statistical data indicated significant differences between the concentration of RNA before and after the effort in favor of the concentration after the effort (Table 3).

Table 3 indicated that there are significant differences between the concentration of RNA (ng/ul) before and after the effort for the sample at hand in the favor of the concentration after the effort. The average RNA concentration before the effort was (4.75 ng/ul), while it was (13.58 ng/ul) reached after the effort.

Table 4 shows that there was a negative correlation with statistical significance between the concentration of RNA after the effort and the rate of lactic acid. The correlation coefficient was -0.84 as it hit the correlation between the concentration of RNA after the effort and support for lactic acid -0.84. On the other hand, there was a positive correlation relation with statistical significance between the concentration of RNA after the effort and the anaerobic ability; the correlation coefficient was 0.84.

The concentration of RNA after the effort was found to have positive correlation with statistical significance with the physical variables. The correlation coefficient of such RNS concentration with the speed endurance in performing punches and kicks ranged between 0.85 and 0.92 and the corresponding correlation coefficient with the strength endurance in performing punches and kicks ranged between 0.75 and 0.87.

Table 5 indicates the existence of differences with statistical significance between the players with high and with low concentration of RNA after the effort in the direction of the players with high concentration in both physiological and physical variables. The calculated value of Z was 2.84 for lactic acid, 2.88 for the anaerobic ability, ranged between 2.71 and 2.91 for the speed endurance and ranged between 2.89 and 2.91 for the strength endurance.

Table 3: Significant difference between RNA (ng/ul) concentration before and after effort for the sample under study using the nonparametric Wilcoxon method (N = 12)

		Pre effort		Post effort		
Variable	Measure unit	M	Sd	M	Sd	Z value
RNA concentration	Ng/ul	4.75	1.06	13.58	3.18	3.07

Z value at 0.05 significance level = 1.96

Table 4: The correlation coefficients of the RNA concentration in ng/ul after effort with the physiological and physical variable under study (N = 12)

Variables			Measure unit	RNA concentration in ng/ul after effort
physiological		Lactic Acid	m mol / L	- 0.84*
		Anaerobic power	m / kgm/s	0.84*
Physical	Speed endurance	Kizami Zuki	Punch/20s	0.85*
		Gyaku Zuki	Punch/20s	0.88*
		Mawashi Geri	Kick/25s	0.89*
		Kizami Mawashi Geri	Kick/25s	0.87*
		Ora Mawashi Geri	Kick/25s	0.86*
		Kizami Ora Mawashi Geri	Kick/25s	0.92*
	Strength endurance	Kizami Zuki	Punch/40s	0.80*
		Gyaku Zuki	Punch/40s	0.87*
		Mawashi Geri	Kick/45s	0.75*
		Kizami Mawashi Geri	Kick/45s	0.86*
		Ora Mawashi Geri	Kick/45s	0.79*
		Kizami Ora Mawashi Geri	Kick/45s	0.77*

Value of the tabulated (r) at level 0.05 = 0.648

Table 5: Significance of the difference between players with high and low RNA concentration (in ng/ul) after effort and those with low concentration in terms of both the physiological and Physical variables for the sample under study using the nonparametric Man Whitney method (N = 12)

				With high concentration		With low concentration		
Variable		Measure unit		M	Sd	M	Sd	Z value
Physiological	Lactic acid L.A		m mol/L	9.50	1.03	12.33	1.05	2.84*
	Anaerobic power		m/kgm/s	102.17	2.93	92.50	3.27	2.88*
Physical	Speed endurance	Kizami Zuki	Punch/20s	42.83	1.17	37.17	2.79	2.82*
		Gyaku Zuki	Punch/20s	32.67	1.03	28.67	1.21	2.91*
		Mawashi Geri	Kick/25s	18.67	1.21	14.67	1.37	2.83*
		Kizami Mawashi Geri	Kick/25s	26.50	1.05	21.17	1.17	2.90*
		Ora Mawashi Geri	Kick/25s	16.50	0.55	13.67	1.63	2.71*
		Kizami Ora Mawashi Geri	Kick/25s	20.00	0.89	16.83	1.17	2.91*
	Strength endurance	Kizami Zuki	Punch/40s	73.67	2.50	67.33	1.86	2.89*
		Gyaku Zuki	Punch/40s	63.67	1.63	54.50	4.97	2.89*
		Mawashi Geri	Kick/45s	26.83	1.17	22.50	1.05	2.90*
		Kizami Mawashi Geri	Kick/45s	41.33	1.21	36.67	1.03	2.91*
		Ora Mawashi Geri	Kick/45s	26.00	0.63	21.50	0.84	2.99*
		Kizami Ora Mawashi Geri	Kick/45s	41.17	1.47	34.67	1.63	2.91*

Value of (z) for both sides at 0.05 significance level = 1.96

DISCUSSION

The results of the present study show that the RNA concentration after the effort is higher than that before the effort (Table 3), which is possibly due to the promotion of the DNA alert to change into RNA. Messenger ribonucileic acid (mRNA) is a molecule of RNA encoding a chemical "blueprint" for a protein product. mRNA is transcribed from a DNA template and carries coding information to the sites of protein synthesis: the ribosomes. Here, the nucleic acid polymer is translated into a polymer of amino acids: a protein. In mRNA as in DNA, genetic information is encoded in the sequence of nucleotides arranged into codons consisting of three bases each. Each codon encodes for a specific amino acid, except the stop codons that terminate protein synthesis. This process requires two other types of RNA: transfer RNA (tRNA) mediates recognition of the codon and provides the corresponding amino acid, while ribosomal RNA (rRNA) is the central component of the ribosome's protein manufacturing machinery.It is known that physical effort works to improve the functions of the body, which would also work to improve the increasing rate of the RNA production, This is consistent with the findings of prior studies [3, 8].

It was shown the existence of a negative correlation with statistical significance between the concentration of RNA after the effort and the lactic acid level as well as a positive correlation relation with statistical significance between the concentration of RNA after the effort and the anaerobic ability, the beard power and beard speed. There was also differences with statistical significance between the players with high and with low concentration of RNA after the effort in the direction of the players with high concentration in both physiological and physical variables (Table 4). The researchers attribute the reduction of the lactic acid level for a group of players with high RNA concentration compared with those with low RNA concentration to the increased level of the RNA rate which may lead to a rise in functions of the muscle, blood and heart. This is because the muscle and heart play a very important role to get rid of lactic acid which is made up as a result of anaerobic oxidation within the muscle cells. The disposal of the increase in the lactic acid rate in the blood and muscles is very important for the completion of treatment [13]. Since the rise of the RNA concentration may lead to the rise in the concentration of different proteins in the muscle, blood and heart which helps the process of fast get rid of lactate in muscles, the rise in the RNA concentration may therefore lead to an increase in the gene expression for the family of the Monocarboxylate (MCTs) carrier. Several studies proved that the top four members of the (MCTs) family are (MCTs1) to (MCTs4), which catalyze the transfer of lactate and pyruvate [14, 15].

The study of Henriette *et al*. [3] confirmed that the increases in the mRNA levels followed changes in transcription, peaking between 2 and 4 h after exercise. These data demonstrate that exercise induces transient increases in transcription of metabolic genes in human skeletal muscle. Moreover, the findings suggest that the cumulative effects of transient increases in transcription during recovery from consecutive bouts of exercise may represent the underlying kinetic basis for the cellular adaptations associated with exercise training. The study by Zhou *et al*. [16] confirmed that the rate of MCT4 mRNA increases during the first 100 minutes training, but decrease during the first post-training 100 minutes. This increase of the RNA concentration may improve the players' ability to get rid of the lactic acid.

Table 5 revealed that the result of anaerobic power, speed endurance and force endurance were high in case of the high expression group compared to low one, while the lactate in high group contrary was lower that the low group.The authors explain the high level of anaerobic capacity in athletes people with high concentration of RNA to an increase in the level of back muscle proteins: actin and myosin. This is because the muscle has an intrinsic ability to change its mass and phenotype in response to activity. This process involves quantitative and qualitative changes in gene expression, including that of the myosin heavy chain isogenes that encode different types of molecular motors. This and the differential expression of metabolic genes, results in altered fatigue resistance and power output.

In this way the tissue can be optimized for power output, rapid movement or fatigue resistance. These contractile characteristics are determined by the type of myosin cross bridge and the type of molecular motor that produces force**.** Training adaptation can be viewed as merely the accumulation of specific proteins. Hence, the altered gene expression that allows for these changes in protein concentration is of major importance for any subsequent training adaptation. The chronic adaptations to any training regimen are likely to be the result of the cumulative effects of repeated bouts of exercise [6, 11] with the initial cellular responses that lead to these long-term adaptations occurring after each (acute) training session [17].

Resistance exercise comprising high-intensity, low-volume loading results in an increased cross-sectional area of the trained musculature, which is mainly due to an increase in muscle contractile protein [18]. Modulation of transcription and translation events contributes to changes in gene expression and subsequent protein synthesis in response to this mode of training [19, 20]. Accordingly, resistance training-induced adaptations that culminate in muscle hypertrophy are the result of integrated gene responses and coordinated molecular events that support the enlargement of preexisting muscle cells via the incorporation of additional myonuclei.

In case of lactate, the increased levels in lower group denates a lower physical fitness compared to the other group, which contain higher gene expression, as with training, there are adaptive physiological changes like increase in volume and number of mitochondria leading to lesser lactate accumulation and higher performance [8, 16].

As for anaerobic power, that was an elevated results (Table 5) in case of high gene expression group compared to lower one.That indicated a high performance and fitness which characterize the high level athletes, leading to higher vertical jump this was in agreement [8]. Speed and force endurance, where that score were higher in case of high gene expression group compared to lower one.

It is well known that training give rise to hypertrophy and hyperplasia of the muscle fibers hence its cross section leading to increase speed and strength, this was in agreement with Roberges and Roberts [21]. Previous works [22-25] have demonstrated the importance of a wide range of gene expression consistent with their central role in defining the adaptive phenotype with differing modes of training. However, for many genes the transcriptional activation and translational responses occur during the first few hours of recovery, returning to basal levels within 24 h of the exercise stimulus. Although much data describing the cellular and molecular mechanisms underlying the transcriptional regulation of gene expression after exercise is available, the effects of prior training on the acute response to different types of contraction has not been investigated. Accordingly, the present study was undertaken to determine the early gene responses after an acute bout of endurance and resistance training. Utilizing a design in which chronically ET or ST athletes undertook exercise in their customary training mode and "crossed over" to perform an acute bout of exercise in their nonfamiliar discipline, we provide novel data on subsets of metabolic and myogenic genes that are likely to be fundamental to the specific exercise-induced adaptation in skeletal muscle.

CONCLUSION

The researchers concluded that the gene expression increase in the blood after maximum intensity training, in addition it was found a relation between gene expression concentration in the blood and some physiological (lactic acid concentration - anaerobic power) and physical (speed endurance – strength endurance) variables.

REFERENCES

1. Roth, S.M. and C. Bouchard, 2008. Genetics and Sport Performance. Pan American Confederation of Sports Medicine (COPAMEDE). Retrieved November. 6. 2009 from www.femede.net/ documentos/ COPAMEDE%2520(1).pdf

2. Bouchard, C., R.M. Malina and L. Perusse, 1997. Genetics of fitness and physical performance. Human Kinetics, Champaign.
3. Pilegaard, H., G.A. Ordway, B. Saltin and P.D. Neufer, 2000. Transcriptional regulation of gene expression in human skeletal muscle during recovery from exercise. Am. J. Physiol. Endocrinol. Metab, 279: 806-814.
4. Febbraio, M.A. and I. Koukoulas, 2000. HSP72 gene expression progressively increases in human skeletal muscle during prolonged, exhaustive exercise. J. Appl. Physiol., 89: 1055-1060.
5. Fitts, R.H., 1994. Cellular mechanisms of muscle fatigue. Physiol. Rev., 74: 49-94.
6. Pilegaard, H., G. Terzis, A. Halestrap and C. Juel, 1999. Distribution of the lactate/H+ transporter isoforms MCT1 and MCT4 in human skeletal muscle. Am. J. Physiol. Endocrinol. Metab, 276: 843-848.
7. Ibrahim, A.M., 1995. Planning principles for both educational and training programs in karate. Manshaet Elmaref, Alexandria, Egypt.
8. Heshmat, H., 2006. ACE Genotype Gene Expression after training and some physiological parameters of fencing national team players. The twenty first conf., soc. of toxicology, Egypt, pp: 20-23.
9. Mahoney, D.J., G. Parise, S. Melov, A. Safdar and M.A. Tarnopolsky, 2005. Analysis of global mRNA expression in human skeletal muscle during recovery from endurance exercise. FASEB J., 19: 1498-1500.
10. Kryk, J., 2009. DNA makes RNA. Retrieved November 11 from http:// www.johnkyrk.com/ DNAtranscription.html.
11. Sanders,W.R. and P.D. Neufer, 1996. Regulation of gene expression in skeletal muscle by contractile activity. In: Handbook of Physiology. Exercise: Regulation and Intergration of Multiple Systems. Am. Physiol. Soc., sect. 12(25): 1124-1150.
12. Goldspink, G., 2002. Gene expression in skeletal muscle. Biochemical Society. Transactions, 30: 285-290.
13. Salama, B.,1994. Sports Physiology. Dar Elfekr Elarabi, Cairo,pp:394.
14. Bonen, A., M. Heynen and H. Hatta, 2006. Distribution of monocarboxylate transporters MCT1-MCT8 in rat tissues and human skeletal muscle. Apple physiol Nutr Metab., 31: 31-9.
15. Bonen, A., M. Tonouchi, D. Miskovic, C. Heddle, J.J. Heikkila and A.P. Halestrap, 2000. Isoform-specific regulation of the lactate transporters MCT1 and MCT4 by contractile activity. Am. J. Physiol. Endocrinol. Metab, 279: 1131-1138.
16. Zhou, M., B.Z. Lin and S. Coughlin, 2000. UCP-3 expression in skeletal muscle: effects of exercise, hypoxia and AMP-activated protein kinase. Am. J. physiol. Endocrinol. Metab., 279: 622-629.
17. Widegren, U., J.W. Ryder and J.R. Zierath, 2001. Mitogen-activated protein kinase signal transduction in skeletal muscle: effects of exercise and muscle contraction. Acta Physiol. Scand, 172: 227-238.
18. Fl-ck, M. and H. Hoppeler, 2003. Molecular basis of skeletal muscle plasticity—from gene to form and function. Rev Physiol Biochem Pharmacol., 146: 159-216.
19. Bolster, D.R., S.R. Kimball and L.S. Jefferson, 2003. Translational control mechanisms modulate skeletal muscle gene expression during hypertrophy. Exerc Sport Sci. Rev., 31: 111-116.
20. Coffey, V.G., A. Shield, B.J. Canny, K.A. Carey, D. Cameron-Smith and J.A. Hawley, 2006. Interaction of contractile activity and training history on mRNA abundance in skeletal muscle from trained athletes. Am. J. Physiol. Endocrinol. Metab., 290: 849-855.
21. Roberges, R. and S. Roberts, 1997. Exercise physiology, exercise, performance and clinical application. Mosby, London.
22. Teran-Garcia, M., T. Rankinen, R.A. Koza, D.C. Rao and C. Bouchard, 2005. Endurance training-induced changes in insulin sensitivity and gene expression. Am. J. Physiol. Endocrinol. Metab., 288: 1168-1178.
23. Vissing, K., J.L. Andersen, S.D. Harridge, C. Sandri, A. Hartkopp, M. Kjaer and P. Schjerling, 2005. Gene expression of myogenic factors and phenotype-specificmarkers in electrically stimulated muscle of paraplegics. J. Appl. Physiol., 99: 164-172.
24. Goldspink, G., 2003. Gene expression in muscle in response to exercise. J. Muscle. Res. Cell Motil, 24: 121-126.
25. Coffey, V.G., A. Shield, B.J. Canny, K.A. Carey, D. Cameron-Smith and J.A. Hawley, 2006. Interaction of contractile activity and training history on mRNA abundance in skeletal muscle from trained athletes. Am. J. Physiol. Endocrinol. Metab., 290: 849-855.