Ovidius University Annals, Series Physical Education and Sport / SCIENCE, MOVEMENT AND HEALTH
Vol. XI, ISSUE 2 Supplement, 2011, Romania
The JOURNAL is nationally acknowledged by C.N.C.S.I.S., being included in the B+ category publications, 2008-2011.
The journal is indexed in: Ebsco, SPORTDiscus, INDEX COPERNICUS JOURNAL MASTER LIST, DOAJ DIRECTORY OF OPEN ACCES JOURNALS, Caby, Gale Cengace Learning

EFFECT OF A RESISTANCE TRAINING PROGRAM ON GH, IGF-1, LACTATE AND DIGITAL LEVEL AMONG FEMALE SWIMMERS

SHOSHA NADIA[1]

Abstract
Purpose. Resistance training is an important stimulus for the muscular tissue. It is described to influence and to be influenced by the hormonal and metabolic state, the purpose of the present study was to prospectively elucidate the effect of resistance training program on growth hormone (GH), the insulin-like growth factor-1(IGF-1), lactate (LA), maximal oxygen uptake (VO2max), pulse rate, muscle strength, and skill performance

[1]Faculty of Physical Education, Zagazig University, EGYPT
Email: soshan62@yahoo.com
Received 07.05.2011 / Accepted 12.07.2011

Methods
After introduction and teaching of the training technique, the participants underwent a two hours resistance-training program, three times per week, for 12 weeks. The program was performed indoors at loom's temperature of 20°C and consisted of callisthenic exercises and rubber-tubing exercises
Results. The results of the present study showed an increase in GH and IGF-1 level; while LA level was decreased after the training program. Pulse rate was decreased and VO2max was increased. Besides, the training program had a positive effect on skill performance.
Conclusions. Our study showed that a resistance training program positively affected the players' fitness and skill performance, increased the muscular strength and provoked an increased GH and IGF-1. It is recommended to use a resistance-training program to increase the physical performance of female.

Key words: growth hormone, Insulin like Growth Factor-1, lactate, maximal oxygen uptake, muscle strength, pulse rate, resistant training, skill performance.

Introduction

The benefits of regular resistance training include; increased muscle strength, endurance and size, increased bone density and strength, reduced body fat, lowered heart rate, and decreased blood pressure after exercise (R. Winett, R.N. Carpinelli, 2001; E. Izdebska et al., 2004). Furthermore, studies have showed that resistance training improves balance, and enhances performance of everyday tasks (M. Cizmic et al., 2003; H. Valkeinen, 2006).

Physical exercise involves increased requirements on pulmonary, cardio-vascular and central nervous system, which result in greater neuroendocrine response. Thus, dynamic exercise has been reported to induce hormonal responses, including an elevation of growth hormone (GH) (W.J. Kracmcr et al., 2001), and IGFI (E. Kiive et al., 2004).

Hormones play important roles in providing energy to the muscle and nerves. They are also involved in replacing that energy.

In addition, they play roles in repairing and building tissues. Growth hormone facilitate the conversion of trigly cerides that stored in the liver to free fatty acids and glycerol that the blood can carry to the muscles and promotes muscle growth (M.A. AL-Cott, 2002) .

The GH is crucial in body anabolism as well as in energy production. Body growth is the generally known role of Gil. However, it has multiple biochemical actions as well The GH influences the metabolism of proteins, carbohydrates and lipids. Most of the growth and metabolic effects of GH are mediated by a peptide hormone, insulin-like growth factor-1 (1GF-1), and there is an interactive effect between them (Z. Laron, 2001). IGF-1 plays an important role in the GH/IGF-1 system which influences and is influenced by physical exercise (T. Radosavljevic et al., 2003).

The amount of Lactic acid that accumulates in muscles is determined by the balance between its rate of production and its rate of removal. these two rates are generally in equilibrium during exercise of low to moderate intensity.

There Fore, Little or no additional Lactic acid accumulates in the muscle. At faster speeds the rate of production will exceed the rate of removal so that additional Lactic acid will accumulate in muscle Fabens. The rate of Lactic acid production in muscle Fabens depends on:

-Swimming speed -rate of oxygen consumption and-type of muscle Fabens. Blood lactate (LA), is an end product of anaerobic glycol sis. Increased amounts of LA can cause fatigue during exercise.

Tests of strength can be used to evaluate the physical fitness, the potential capacity for sport and athletic performance, and suitability for the demands of specific vocations.

There is an increasing interest in studying the hormones related to GH/1GF-I axis.

Presumably because, during recent years, the problems with GH doping have increased (A.E. Rigamonti et al., 2005; M. Healy et al., 2003).

The purpose of the present study was to investigate the effect of resistance training program on GH, IGF-1, LA, pulse rate, V02 max, the muscular strength (hand grip, arm, back, leg, and abdominal), and skill performance in female swimming.

Material and methods

Objects:

The study group consisted of ten physical-educations about ten swimmers from zamalek female swimmers team. The mean age was 18.2 ± 1.4 years, the mean weight was 65.2 ± 3.6 kg, and the mean height was 166.4 ± 3.8 cm. All participants were in good health with no physical or psychic diseases. No medication was used by any of them throughout the program. The study was carefully explained and informed was given by all subjects. The study was performed at the Zamalik sport Club.

Method:

After introduction and teaching of the training technique, the participants underwent a two hours resistance-training program, three times per week, for 12 weeks. The program was performed indoors at room's temperature of 20°C and consisted of callisthenic exercises and rubber-tubing exercises see below.

Table 1: The components of the Callisthenic exercises

Upper body exercises	Arm exercises	Abdominal exercises	Back exercises	Lower body exercises
Straight leg push up	Upright dips	Hanging knee raise	Knee press	Quadriceps lift
Elevated upper body push up	Bench dips	Curl-up	Back lift	Gluteal and hamstring lift
Pull up		Supported leg raise		Calf raise

Rubber-tubing exercises, /.s *a way to develop strength by* the use of rubber tubing. It provides resistance.

Measurement of muscle strength:

A dynamometer was used to measure the muscle strength (grip, arms, back, leg and abdominal muscles strength).

Blood samples:

Five ml blood sample was collected at standardized time (09.00 - 10.00 am) after 8-hour fasting time. The first sample was taken at the first training day.

Another blood sample was collected at the last training day. Blood samples were centrifuged for 10 minutes at 4500xg.

Serum was collected and frozen at -70°C until analysis. Lactate level was measured by using Accusport. GH and IGF-1 were measured with the use of gamma counter and commercial kits (manufactured by Diagnostic System Laboratories Inc.).

The theoretical sensitivity or minimum detection limit was 0.08 and 0.12 ng/ml for growth and IGF-1, respectively. The intra-assay precision was determined from the mean or 10 replicates each.

Physiological measurement:

Pulse rate at rest was counted before and after the training program. V02 max was connecting steady state pulse rate to the specific workload (kgm)

Skill performance:

All participants underwent a skill performance tests, including Ari-Seoi-Noge, Hane-Goshi, Uchi-Mata, before and after the training program.

Statistics:

The SPSS program was used. Mean and standard deviation were calculated. Student's t-test was used for continuous data. As the sample was small, non -parametric method was used. Statistical significance was considered at $p< 0.0$

The Results

- The obtained date showed that.
- Pulse rate, V02 max, lactate: A significant decrease in pulse rate and in lactate together with a significant increase in V02 max was found after.

Table 2: Pulse rate, V02 max and lactate before and after the 12-week resistance exercise-training program.

Parameters	Before m±SD	After m±SD	t-test	p-value
Pulse rate beats /min	73.2-fc9.50	66,4 ±2.1	24,00	< 0.05
V02 max ml/kg/min	47.6 ±2.9	51.2 ±2.7	29,19	< 0.05
Lactate mmol/L	1.4 ±0.9	0.8 ±0.13	38.18	<0.05

min = minute, V02 = Maximal oxygen uptake, m = mean, SD = standard deviation

- **GH, IGF-1:** A significant increase in GH and IGF-1 was found after the resistance exercise-training program, compared to the value before the training program, table 3.

Table 3: GH and IGF1 before and after the 12-week resistance exercise-training program.

Para meters	Before m±SD	After m±SD	p-vahie
GH ng/ml	0.42 ±0.6 &	1.9 ±0.8	<0.05
IGF-1 ng/ml	82.1 ±7.4	130.0 ±8.4	<0.05

m = mean, SD = standard deviation, GH == Growth Hormone, IGF-1 = Insulin-like Growth Factor 1, in = mean, SD = standard deviate

Muscle strength: (Hand-grip strength, arm strength, leg strength, back strength and abdominal strength) increased significantly.

Table 4: Handgrip, arm, leg, back and abdominal strength before and after the 12-week resistance exercise-training program

Parameters	Before m±SD	After m±SD	p-value
Handgrip Newton /kg	42.3 ±3.7 -r	45.8 ±3.1	<0-05
Arm Newton /kg	25.4 ±1.1	32.1 ±1.2	<0.05
Leg Newton /kg	73.9 ±4.8	78.7 ±5.2	<0.05
Back Newton /kg	54.1 ±3.6	58.4 ±4.2	<0.05
Abdominal Newton /kg	35.7 ±2.7	39.4 ±2.61	< 0.05

m::= mean, SD = standard deviation.

Significant improvement of the Digital Level, table 5.

Table 5: Digital Level Scores before and after the 12-week resistance exercise-training program.

	Before	After	t-test
Variables	m±SD	m±SD	
100 m free Style	61.96 ±3.45	59.84 ±3.22	<3.72

Results' Discussion

This prospective study showed significant decrease in pulse rate after the resistance exercise-training program, compared to the values before. This was previously stated by Kamath et al, whose application of the frequency analysis of heart rate variability during exercise has shown that the sympathetic frequency curve is decreased (M.V. Kamath et al., 1991). A rational explanation is that the pre-training general predominance of the sympathetic tonus over the parasympathetic tonus (vagal) was changed by the training, leading to a predominance of the vagal tonus (T. Doering et al., 2003).

In the present study, lactate concentration decreased significantly after the resistance-training program, compared to pre-program levels- This finding may seem to contradict the finding of Robergs and Roberts who showed that exercise causes increased lactale levels. However, they also pointed out that in well-trained altimeters lactate is reduced, at rest and after exercise, compared to untrained subjects (R. Robergs, S. Roberts, 1997). In which Lactate accumulates and formation exceeds pyruvate oxidation. During • exercise lactate is eliminated in liver, heart, and resting and working muscle.

Muscle, elimination depends on plasma concentration, fiber type, and fiber conditions. Training was described to diminish glycogenolysis and lactate production through its influence on hormonal response, mitochondrial oxidative capacity and Training also increases lactate clearance. Thus, the plasma lactatet level is a finely balanced result of the interplay between many factors of importance for endurance exercise (B. Stallknecht et al., 1998).

The obtained data of the present study showed a significant elevation in V02 max after the resistance-training program. This finding coincides with the report published by de Mello Meirelles et al who reviewed the literature considering the acute effects of resistance exercise on energy expenditures (C. de Mello Meirelles, P.S. Chagas Gomes, 2004). The authors concluded that resistance exercise includes an acute increase in energy expenditure, through the energy cost of training exercise session itself and through the excess post-exercise oxygen consumption.

The hormonal response depends on several factors, such as the type, duration or intensity of exercise and the physical state of the subject. Other factors, such as increased core temperature during exercise have also been reported to influence the hormonal response, suggesting a thermal effect for exercise-induced hormonal stimulation (T. Vigas, J. CeIko, J. Koska, 2000). The elevation in GH and 1GF-1 levels after the 12 weeks resistance-training program is in accordance to the results of other studies. Similar findings were reported by Craig ct al (1989) who in a prospective study of young men found that 12 weeks of resistance training increases basal GH concentrations by 45% ($p < 0.05$) and that resistance exercise training doubles the post exercise GH concentrations (B.W. Craig, R. Brown, J. Everhart, 1989). Exercise intensity above lactate threshold and for a minimum of 10 minutes was speculated to elicit the greatest stimulus to the secretion of GH and to amplify the pulsatile release of GH at rest, leading to increase in the 24-hour GH secretion (R.J. Godfrey et al., 2003).

GH has well-known influences on biolysis (J. Jorgcnsen et al., 2003). The GH increases free fatty acids and inhibit glucose uptake by peripheral tissues- Thus, conserving blood glucose which causes a greater stimulation of muscle glycogen synthesis through the accompanying increase in IGF-1 and rapid increase in skeletal muscle lipid catabolism (S.R. Rioom et al., 1976)

GH stimulates the release of IGF-I, which in turn mediates many of the effects of GH at the tissue level. IGF-1 is produced by the liver as well as by the muscles and has anabolic effects. Its concentration is related to the concentration of growth hormone. IGF-1 gives rise to an increase in muscle bulk. Additionally, GH has insulin-like effects, increasing the uptake of amino acids and their incorporation into muscle protein (O. Rutherford, 1999).

Measurement of muscle strength is a well-known method of monitoring improvement after resistance exercise-training programs (L. Gettman, 1988). All participants in the present study showed significant increase of the muscle strength in all areas tested (hand grip, arm, back, leg and abdominal muscles) after the 12-week training period. Additionally, there was a significant increase in skill performance tests. Similar improvements have been reported by other authors (R.V. Breed, W.B. Young, 2003).

Conclusion

The present study showed that a resistance training program positively affected the players' fitness and skill performance, increased the muscular strength and provoked an increased GH and IGP-1. Resistance training program can be recommended to increase the physical performance of female swimmers.

References

AL-COTT, M.A., 2002, *Sports physiology and swimming training,* part 2 , Book Center com. , Cairo , Egypt, pp.37-38.

BREED, R.V., YOUNG, W.B., 2003, *The effect of a resistance training programmed on the grab, track and swing starts in swimming.* J Sports Sci 21(3): 213-20.

CIZMIC, M., ZIVOTIC-VANOVIC, M., ZIVANIC, S., DRAGOJEVIC, R., 2003, *Effect of a two-week program of individually monitored physical activity on insulin resistance in obese non-insulin-dependent diabetics.* Vojnosanit Pregl; 60(6): 683-90.

CRAIG, B.W., BROWN, R., EVERHART, J., 1989, *Effects of progressive resistance training on growth hormone and testosterone levels in young and elderly subjects.* Mech Ageing Dev 49(2): 159-69.

DE MELLO MEIRELLES, C., CHAGAS GOMES, P.S., 2004, *Acute effects of resistance exercises on energy expenditure: revisiting the impact of the training variables.* Rev Bras Med Esporte 10(2): 131-138.

DOERING, T., STEUERNAGEL, B., KONITZER, M., FISCHER, G.C., 2003, *Literature review of the latest research results concerning the positive effect of exercise therapy in chronic heart insufficiency.* Forsch Komplementarmed Klass Naturheilkd 10(1): 26-34.

GETTMAN, L., 1988, *Finesses testing.* Leaand Febiger, Philadelphia.

GODFREY, R.J., MADGWICK, Z., WHYTE, G.P., 2003, *The exercise-induced growtli hormone response in athletes.* Sports Med 33(8): 599-613.

HEALY, M., GIBNE, J., RUSSELL-JONES, D.L., PENTECOST, C., CROOS, P., SONKSEN, P.H., UMPLEBY, A.M., 2003, *High dose growth hormone exerts an anabolic effect at rest and During exercise in endurance-trained athletes.* J Clin Endocrinol Metab; 88(11): 5221-6.

IZDEBSKA, E., CYBULSKA, I., IZDEBSKIR, J., MAKOWIECKA-CIESIA, M., TRZEBSKI, A., 2004, *Effects of moderate physical training on blood pressure variability and hemodynamic pattern in mildly hypertensive subjects.* J Physiol Pharmacol; 55 (4): 713- 24.

JORGCNSEN, J., FCRAG, M., KANALEY, J., MOLLER, J., HANSEN, T.K., MILLER, N., CHRISTIANSEN, J.S., ORSKOV, H., 2003, *Exercise, hormones, and body temperature, regulation and action of GH during exercise.* J Endocrinol Invest 26(9): 838-42.

KAMATH, M.V., FALLEN, E.L., MCKELVIE, R., 1991, *Effects of steady state exercise on the power spectrum of heart rate variability.* Med Sci Sports Exec 23(4): , 428-34.

KIIVE, E., MAAROOS, J., SHIIK, J., TORU, I., HARRO, J., 2004, *Growth hormone, cortisol and prolactin responses to physical exercise: higher prolactin response in depressed patients.* Prog Neuropsychophannacol Biol Psychiatry 28(6): 1007-13.

KRACMCR, W.J., DUDLEY, G.A., TCSCH, P.A., GORDON, S.E., HATHCR, B.M., VOICK, J.S., RATAMESS, N.A., 2001, *The influence of muscle action on the acute growth hormone response to resistance exercise and short-term detraining.* Growth IIorm IGF Res; 11(2): 75-83.

LARON, Z., 2001, *Insulin-like growth factor 1 (1GF-1); a growth hormone.* Mol Pathol 54(5): 311-6.

VALKEINEN, H., HAKKINEN, A., HANNONEN, P., HAKKINEN, K., ALEN, M., 2006, *Acute heavy- resistance exercise-induced pain and neuromuscular fatigue in elderly women with fibromyalgia and in healthy controls: Effects of strength training.* Arthritis Rheum; 54(4): 1334-9.

RADOSAVLJEVIC, T., TODOROVIC, V., VUCEVIC, D., SIKIC, B., 2003, *The growth hormone axis.*

RIGAMONTI, A.E., CEILA, S.G., MARAZZI, N., DI LUIGI, L., SARTORIO, A., MULLER, E.E, 2005, *Growth hormone abuse: methods of detection.* Trends Endocrinal Metab 16(4):160-6.

RIOOM, S.R., JOHNSON, R.H., PARK, D.M., RENNIE, M.J., SULAIMAN, W.R., 1976, *Differences in the metabolic and hormonal response to exercise between racing cyclists and untrained individuals.* J Physiol 258(1): 1-18.

ROBERGS, R., ROBERTS, S., 1997, *Exercise physiology.* Mosby, St Louis, USA.

RUTHERFORD, 0., 1999, *Hormones as Stimuli for Muscle Growth.* Basic Appl. Myol.; 9(6): 285-288.

STALLKNECHT, B., VISSING, J., GALBO, H., 1998, *Lactate production and clearance in exercise. Effects of training.* A mini-review-Scand J Med Sci Sports.; 8 (3): 127-31

VIGAS, T., CEIKO, J., KOSKA, J., 2000, *Role of body temperature in exercise-induced growth hormone and prolactin release in* *non-trained and physically fit subjects.* Endocr Regul 34(4): 175-80.

WINETT, R., CARPINELLI, R.N., 2001, *Potential health-related benefits of resistance training.* Prev Med; 33(5): 503-13.