مجلة سيناء لعلوم الرياضة

The physiological effects of aquatic exercises on circulatory system, neurohormones and growth factors of swimmers

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مستخلص البحث باللغة الاجنبية

The research aims to study ACE and some biological variables to select short-distance swimmers, It is hypothesized that ACE and some biological variables might help select short-distance swimmers, The researcher used the descriptive method of a sample of short distance swimmers, no.=15, from Port Said clubs, aged 18.6, height 181.2 cm, and weight 78.3 kg. Angiotensin-converting enzyme, heart rate, lactate, respiratory rate, and vital capacity together with growth hormone and testosterone. Elisa technique was used for ACE and hormones detection, ACU sport for lactate, and spirometer for solid ability. It was considered to detect heart rate and respiratory rate, According to the lab reports, the results indicated that the data of the different variables overwhelmed the average levels of ordinary persons, It is concluded that ACE and some biological variables of this study might be good indicators for selecting short-distance swimmers.

Introduction :

Hormone secretion from many endocrine glands is triggered by the anterior pituitary gland. As an example, the adrenal cortex secretes cortisol when it is stimulated by adrenocortical trophic hormones. In addition, hormones that activate the thyroid gland cause the release of thyroid hormones 3 and 4. Additionally, insulin growth factor #1 (somatomedin) is connected to growth hormone. Gonadotrophins also encourage the testis to release testosterone, the sex hormone. Anterior pituitary gland secretion regulation is a key function of the hypothalamus (Barrett et al., 2010).

Ayuk and Sheppard (2006) found that growth hormone stimulates growth by lowering plasma fat, increasing lean body mass, decreasing body fat, and improving nitrogen balance. It also decreases body fat and stimulates metabolism. (Ayuk and Sheppard, 2006).

Sports activities are a critical element of influencing human development. Adjusting the forms of exercises is a must to cope with the interests and needs of athletes.

Participation in athletic activities is essential for shaping human maturation. In order to meet the demands and interests of athletes, it is necessary to modify the types of exercises.

Swimming has the ability to influence swimmers' executive function due to the massive physiological effects of the activity on hormonal, neurological, and circulatory systems. Muscle contractions and coordination must vary to meet the physical demands of the maritime environment. The improvement in cardiovascular health was accompanied by an improvement in brain blood flow and circulation. It seems to

help with hormonal and brain structure growth and maintenance. The combination of the buoyancy of the water and the analgesic effects of hydrostatic pressure leads to increased exercise retention, according to the research (Maglisho, 2003).

The benefits of aquatic therapy

The term "aquatic therapy" refers to a type of fitness regimen that makes use of a heated pool. This rehabilitation program is utilized by physical and occupational therapists to enhance a patient's mobility and strength. Personalization is key when it comes to programs.

Exercising in water

Less strain on the joints is an advantage of exercising in water. The weight of your body is only supported by your joints to the extent of 10% when the water reaches your neck. Joints that aren't able to support as much weight above water may experience:

- A decrease in the effects of gravity on them.
- It aids in the progression to land-based exercises by increasing your range of motion thanks to the relaxing effects of hot water on muscles.
- It gives you a stable base from which to move, stretch, walk, and build strength in your muscles and joints. (Colado et al., 2009).

Benefits of Aquatic Therapy:

- Improving your muscle strength and tone.
- Increasing your heart and lung strength.
- Increasing your fitness level and endurance.
- Reducing stress.
- Decreasing swelling and improving blood flow.
- Increasing your range o motion and flexibility. (Colado et al., 2009).

Research problem

Aqua exercises are physical and motor exercises performed in the water medium.

The goal is to utilize the positive effect of water in applying these exercises by holding pressure on the body and providing increased buoyancy. Aqua exercises have a good reputation and many benefits that pushed many trainers and physicians to recommend these exercises as prophylaxes and therapeutic methods for many-body systems and help cure medical problems and injuries.

These benefits urge the researchers to examine the physiological effects of aquatic exercises on swimmers' circulation system neurohormones and growth factors.

It is hypothesized that the aquatic exercises might positively affect swimmers' circulatory system and hormonal profiles.

Research procedure

The researcher used the experimental method for its suitability for the research aim.

The researcher sample:

We examined fourteen healthy male swimmers aged (18.8y), height (176.8cm), weight (73.8kg), practical history of (9y) from different clubs in Port-Said.

All participants were free from diseases. They refrained from caffeine, medications, and supplements.

Research hypothesis

Table (1): Basic characteristics feature of the sample

Variables	Mean	SD	Skewnes
Age (years)	18.8	0.25	1.4
Height (cm)	176.8	3.8	-0.26
Weight(kg)	73.8	3.1	0.19
BMI (kg/m^2)	23.2	0.53	0.56

Table (1): indicated that the skewness ranged between (±3) indicated that the samples are Homogene.

Data collection tools:

- Height measured with a stameter.

measuring one's weight on a medical scale.

BMI is the result of dividing one's weight by one's height squared.

- Using AccuSport for lactic acid, breathing rate, and chest movement.

- Glucose measured with a microscope.

- A 5-milliliter blood sample for hormone testing; a pulse oximeter, syringes, test tubes, centrifuge, vortex, and alcohol.

Hormone testing with commercial kits and the enzyme-linked immunosorbent assay (ELISA) utilizing blood that contains the anticoagulant EDTA:

- Hemopoietin.

development hormone.

One IGF.

ACTH, epinephrine.

Identifying the hormone in a clinical laboratory

The Coleman was cooled before conveying the blood.

- Put in deep refrigerator.

Pilot study

The researcher determines a pilot study on a sample of 4 young swimmers of the primary samples and the same community 2days before the main study.

The season is to investigate the soundness of the equipment and tools, know the problems that might face the research, and solve such issues.

The pilot study results indicated that the preparations are good enough so are the devices and tools.

We designed the aquatic exercises program according to five “R” principles (Hatfield, 2013).

- Range of motion: the complete movement capability of a joint to improve the combined range

of motion, each muscle acting upon a given joint must be exercised.

- Resistance: the exercise can be performed through a full range of motion.
- Repetitions: the number of repetitions must be according to the results wanted.
- Rest: the working muscle needs a rest of 2-4 minutes between each set of repetitions to function near total capacity again.
- Recovery: is the adequate time that must be allowed between one workout and the next to prevent reaching overtraining.

The proposed aquatic exercises

- Training duration was eight weeks.
- Weekly training number (3) sets, total 24sets.

The training set was composed of warming up, the main training period, and cooling down.

- Warming up (10) minutes, cooling down (5min).
- Intensity of training (50-100%).
- Main training of (60) minutes.
- Rest intervals.
- General physical preparation.
- Special physical preparation.

Aquatic exercises content

- Flex your joints and build strength in your arms, shoulders, and neck with these stretches for the upper body.
- Joints are loosened and muscles in the legs, hips, back, and buttocks are strengthened with lower body stretches.
- Strengthening the muscles in the upper body.
- The strengthening of the lower body.
- Strengthening the complete body through aerobic exercise.
- Workouts executed using a kickboard and paddles

Statistical analysis

Using (SPSS) including:

- Arithmetic mean.
- Median.

- Standard deviation.
- Skewness.
- T-test for the difference of pre-post aquatic exercises.

Results

Table (2) reported the fundamental physiological changes pre-post aquatic exercises, and that post-exercise, all the physiological variables significant deceased.

Table (3) showed that aquatic exercises led to a significant increase in growth factors.

Table (4) revealed that aqua exercise induced a significant decrease in epinephrine and ACTH, which indicate decreased stress.

Table (5) showed a significant increase in serum Nitrite and VEGF post aqua exercise leading to increased blood flow and positive circulation.

Table (2) Basic physiological variables before and after aquatic exercise.

Variables	Before		After		Sig
	M	SD	M	SD	
Pulse Rate (c/min)	82.2	4.8	74.4	3.2	*
Respiratory Rate (N/min)	14.3	2.3	12.1	1.4	*
Lactate (mmol/L)	1.7	0.6	1.1	0.4	*
Glucose (mg/dl)	92.4	5.2	81.3	3.8	*

Table (2) indicated significant changes of variables for the sake of post aquatic exercises.

Table (3) growth factors changes before and after aquatic exercise.

Variables	Before		After		Sig
	M	SD	M	SD	
Growth H. (mg/ml)	0.9	0.01	3.2	0.6	*
IGF (1) (mg/ml)	31.2	10.2	45.3	7.4	*
Erythropoietin (pg/ml)	22.04	6.4	55.9	7.1	*

Table (3) indicated significant changes of variables for the sake of post aquatic exercises.

Table (4) Neuro-hormones changes before and after aquatic exercise.

Variables	Before		After		Sig
	M	SD	M	SD	
Epinephrine (P mol/L)	212.4	23.5	170.5	12.6	*
ACTH (pg/ml)	112.6	8.4	75.8	6.2	*

Table (4) indicated significant changes of variables for the sake of post aquatic exercises.

Table (5) Nitrite and vascular endothelial growth factor before and after aqua exercises.

Variables	Before		After		Sig
	M	SD	M	SD	
Serum Nitrite (mmol/ml)	12.4	3.6	16.5	4.2	*
Serum VEGF	98.6	20.1	116.3	22.2	*

Table (5) indicated significant changes of variables for the sake of post aquatic exercises.

Discussion

Table (2) revealed the lactate concentration of swimmers at rest before aquatic exercises (1.7 mmol/L) and after aquatic activities at rest (1mmol/L). Moungios(2006)

stated that (1mmol/L) lactate at rest is the average value. Moungios(2006) added that lactate could go to 20mmol/L within half a minute at the high-intensity effort.

(Greenhaff and Timmons, 1998, Biossean and Delamarche, 2000, Fitts, 2004) Other factors were affecting lactate level: duration of exercise and heredity, nutrition, and age.

(Sorichter et al., 1999) reported that fatigue is associated with lactate plus H+ion.

Table (2) also showed a lower Pulse Rate level at rest before aquatic exercise than Pulse Rate after aquatic exercise.

The findings here are in line with those of (Zahran 2016). According to Aubert et al. (2001), people who are physically fit tend to have a slower resting heart rate because their parasympathetic activity is higher. As an alternative, reduce sympathetic activity (Chacon et al., 1998).

According to Calai et al. (2002), the sinus node may undergo intrinsic adaptation, which can cause exercise-induced bradycardia. Also, the heart's muscles might enlarge, a process known as hypertrophy, as a result of long-term adaptive reactions. The ventricles' muscular mass is increased through hypertrophy, which allows the heart to produce higher force with each beat (Wilmore and Costill, 1994).

The data in Table (2) show that the average number of breaths per minute for swimmers at rest is 12.1 after aquatic activity, down from 14.3 before. It was a sign of healthy lung function since swimming on a daily basis influences the respiratory muscles, which in turn improves oxygen use and delays weariness. According to (Ahmed 2017), this outcome is consistent.

According to studies, this view is supported by the fact that trained athletes have stronger muscles surrounding their lungs, allowing them to take more air and maintain this process for longer periods of time (Hatfield, 2013). Because of their greater stature, swimmers may also have larger lungs. Additionally, swimmers may have a vital capacity that is equal to 75% of their total lung capacity, meaning that the usable portion of their lungs, also known as vital capacity, may be significantly larger than the norm (5.5-4.5 L). According to Barrett et al. (2010), training can improve lung function, allowing for more effective processing of air and increased oxygen extraction, while simultaneously decreasing the usual breathing rate..

Table (2) revealed that glucose concentration significantly decreases after aquatic exercises, which improves the healthy side and is a good sign in favor of the effect of aquatic exercise, which can also be practiced the people affected by high levels of blood sugar (diabetes mellitus).

(Ganong, 2000) stated that glucose is a significant fuel of humans' tissues and the fetus's universal power. It is converted to other carbohydrates such as glycogen for storage. Also, glucose is the fuel of aerobic exercise. It is biochemically changed to lactate in case of shortening of oxygen. Glucose is the primary fuel used by the body due to its simple metabolism issue to produce energy by the athletes.

According to Table (3), the concentration of growth hormone was higher following aquatic exercise for the swimmers compared to the average level after resting after aquatic exercise. It is possible that swimmers' status might improve with this increased amount of growth hormone. Research on swimmers'

performance has led them to believe that growth hormone—the biggest and most complex protein made by the pituitary gland—is the most abundant hormone (Hatfield, 2013). During adolescence, the body secretes the most of it, which aids in the growth of muscles. Exercise, stress, low plasma glucose concentration, and sleep are additional factors that can impact growth hormone release. He went on to say that growth hormones promote long bone growth, protein synthesis, and tissue amino acid intake. Growth hormone is sometimes referred to as the "fountain of youth" due to its ability to prevent glucose from being used up by the body by blocking insulin's effects and boosting the mobilization of fatty acids.

There is some evidence that exercise can increase the secretion of growth hormone and other metabolic hormones, including insulin-like growth factor (1). Positive nitrogen results from enhanced muscular growth and strength, which in turn may boost fitness, standard, and power. According to Heyward (1991), Howley and Franks (1992), and Petterson and Bryant (1995), it is crucial for swimmers to select it and achieve a better score.

(Hatfield, 2013) stated that IGF (1) is produced by the liver and skeletal muscles and produces an anabolic effect on tissues and organs. Its concentration is related to the concentration of growth hormone and hence induces an increase in muscle size. They also added that most, if not all, of the growth effect of growth hormone, result in fact to the direct action of IGF (1) and the stem cells found in the muscle through the impact of exercise, which in turn lead to the increase in the size of skeletal muscle.

The increase in erythropoietin concentration was reported in table (3) may be

triggered due to the action of practices. They stimulate the kidney and liver for the production of erythropoietin hormone. So, it stimulates the release of erythrocytes to increase oxygen content transported by the hemoglobin contents of RBCs (Barrett et al., 2010). They also added that the usual stimulus for erythropoietin secretion is hypoxia, such as testosterone and cobalt salts.

Table (4) showed that epinephrine and ACTH decreased significantly after the aquatic exercise of swimmers. This result indicated that aqua exercises reduced stress due to the exercise training in water, which positively reduces neurohormone. This is by the data of (Williams 2012).

(Ganong, 2000) reported that ACTH regulates the growth and function of the adrenal cortex. Hence, it increases the synthesis and release of adrenal steroids by enhancing the conversion of cholesterol to pregnenolone. Also, excessive ACTH production increases the secretion of cortisol in the blood.

Epinephrine and norepinephrine, and dopamine are also named catecholamines. They affect the heart's force and rate of contraction and increase myocardial excitability, causing extrasystoles. Catecholamine increases alertness evokes more anxiety and fear, which are called stress hormones (Ganong, 2000). The decreased level of epinephrine concentration after the aquatic exercise, as revealed in table (4), maybe induced due to aquatic exercise whose benefits allow less stress on the joints. Also, the water lessens gravity forces on joints, improves the range of motion and flexibility, increases blood flow and relaxes muscles, and provides support for the movement, stretch, walking, strengthening muscle and joints. Also, it helps to progress the

exercise on land and increases fitness.

(Sherlook et al., 2013) supported the view of the importance of training on the aquatic environment due to its positive effect on neurohormones and growth factors affecting muscles and brain, due to the physical properties of water, namely density and specific gravity and its importance for the maintenance of body position and dynamic balance.

They also added that the buoyancy effect counteracts the gravitation force and affects the cognitive stimuli, resulting in brain function improvements. They said that hydrostatic pressure supports blood return to the heart, lymphatic redistribution, and cerebral blood flow. (Man et al., 2010), stated that the viscosity of water increased the force required to elicit movement, which stimulates neuromuscular recruitment patterns and adaptation and cerebral functions.

Table (5) revealed that nitric oxide (Nitrite) increased significantly after aquatic exercises compared to the resting stage before activity. This result is the following (Mourat et al., 2010), they denoted that exercise restores physiological cardio-vascular responses.

The Nitrite action affects the cardio-vascular system inducing a relaxation effect that increases blood flow and stimulates muscular and brain function, which indicates a positive pathway of the neuro-vascular system, also promoting neurocognitive scaffolding (Park and Reuter, 2009) and affecting working memory.

Table (5) revealed that aqua exercises increased vascular endothelial growth factor (VEGF) after the activities compared with the resting stage before aqua exercises.

(Gulik, 2010) reported the effect of an aquatic intervention on increasing blood flow related to developing nitric oxide together with VEGF. They reported that the exercise effect induces a positive correlation with VEGF expression as exercise induces several pathways that are known to be important for regulating angiogenesis, as VEGF is critical for basal and activity-induced regulation of skeletal muscle CA pillarization and increase in blood flow.

The initial results and discussion indicated that the research hypothesis had been realized.

Conclusion

Aquatic exercises affect the muscular and neural system resulting in improvement of the firm and circulation system via growth factors secreted (growth hormone, IGF (1), and erythropoietin H., together with nitric oxide). And vascular endothelial growth factor (VEGF).

Physical properties provide further opportunity for brain adaptation and function via
neurohormones, *epinephrine, norepinephrine, and dopamine*).

Aquatic exercises may be the ideal mode of training and medicine to decrease stress and enhance brain functions together with the improvement of physical fitness.

Recommendation

It is recommended to use aquatic exercises as it is the best method for rehabilitation and healing of many injuries prescribed by clinicians and therapists due to its benefit for the physical state and health.

References

1. Ahmed, El Taeb, 2017: Effect of variation of physical loads on stem cells and some physiological and physical variables of soccer

palyers. Fac. of Physical Education, Benha Univ.
2. Aubert, A., Beckers, F. and Ramakers, D. 2001: Short term heart rate variability in young athletes. J. Cardiol, 37,85.
3. Ayuk, J. and Sheppard, M. 2006: Growth hormone and its disorders, post grade Med. J., 82,24.
4. Barrett, K., Barman, S. and Boitano, S. 2010: Review of Medical Physiology, McGraw Hill, USA, 280.
5. Boisseau, N. and Delamarche, P. 2000: Metabolic and hormonal responses to exercise, Sports Med., 30,405.
6. Calai, A., chacon, M. and Forti, V. 2002: Effect of aerobic exercise on heart rate, Brazilian J. Med. Biol. Res. 35,741.
7. Chacon, M., Forti, V. and Catai, A. 1998: Cardiorespiratory adaptation in men by aerobic training, Brazilian J. Med. Biol. Res. 31,705.
8. Colado, J., Tella, V., Triplett, N. 2009: Effect of a short term aquatic program on strength and body composition J. of strength and conditioning research.
9. Fits, R. 2004: Mechanisms of muscular fatigue, Exercise Bioch 279.
10. Ganong, W. 2000: Review of medical physiology, A Lange Medical Book, USA.
11. Greenhaff, P. and Timmons, J. 1998:Interaction between aerobic and anaerobic metabolism during intense muscle contraction, exercise and sport Sc. Rev. 26,30.
12. Ogulick, D. 2010: Effects of aquatic intervention on the cardio pulmonary system in the geriatric population, Topics in geriatric rehabilitation 26,93.
13. Hatfield, F. 2013:Fitness, ISSA.
14. Heyward, V. 1991: Advanced fitness assessment, Human Kinetics, USA.

15. Howley, E. and Franks, B. 1992: Health/Fitness instructor's handbook, Human Kinetics, USA.
16. Maglisho, E. 2003:Swimming faster, Magfill Publish. California, 501.
17. Man, D., Tsang, W., Hui, C. 2010: Do older Tai chi practitioners have better attention and memory function?J. of alternative, complementary Medicine 16,1259.
18. Mougios, V. 200: Exercise biochemistry, Human Kinetics, USA, 620.
19. Mourot, L., Teffaha, D, Bouhaddi, M 2010: Exercise rehabilitation restores physiological cardiovascular responses of short water immersion in patients of chronic heart failure. J. cardiopulmonary rehab and prevention 30,22.
20. Park, D., Reuter, L. 2009:The adaptive brainAnn. Reviews of psychology 60,173.
21. Peterson, J. and Bryant, C. 1995: Exercise lite Medicine or placebo, fit Manag 11,28.
22. Sherlock, W., Guyton, H., James, R. 2013: The physiological effects of aquatic exercise on cognitive function in the aging population Int. J. of aquatic research and education 7,266.
23. Sorichter, S., Flushendorf, B. and Mair, J. 1999: Muscle injury induced by eccentric muscle action.
24. Williams, M. 2012:Hormones, cardiovascular and respiratory responses to exercise. Circulation 12,1040.
25. Wilmore, J. and Costill, D. 1994: Physiology of sport and exercise Champaign, Human kinetics, p. 120.
26. Zahran, M. 2016: Effect of anaerobic training on stem cells and physiological variables of male athletes, PhD thesis