

Effect of hydrotherapy on some biological variables of swimmers

*Dr/ Saleh Abdelsalam Eltarabily

**Dr/ Tamer f.ELsaid Ahmed

Abstract

The current study was performed to investigate the effect of hydrotherapy exercise programs on some biological variables of swimmers.

This study included swimmers subjected to a hydrotherapy program to detect some biological variables {physiology: pulse rate, lactate, vital capacity} {biochemistry of nervous system: serotonin, cortisol, B endorphin} {growth: I G F 1, b-F G F, T. protein}.

The analyses of the different variables occurred pre or post hydrotherapy program. A blood sample was drained (5ml) before and after the program, which lasted 12 weeks, performed in summer 2019,2020.

The results reveal statistically significant changes in the different variables detected for the sake of the post hydrotherapy exercise program.

Conclusion: hydrotherapy provide support, increase circulation to the brain, muscles, bones, and reduce fatigue and pain due to enhance endorphins and stimulate neurostimulators and reduce stress and maintain nutrients for energy production

Keywords: hydrotherapy, swimmers, biological variables, neurostimulators, stress

Introduction:

Hydrotherapy is the external or internal use of water in any of its forms (water, ice, steam) for health promotion or treatment of various diseases with various temperatures, pressure, duration, and site.

It is one of the naturopathic treatment modalities used widely in ancient cultured including India, Egypt, and China (Moor,1997,

O'roure,1995) though many countries used water to produce different physiological therapeutic effects on other parts of the system for maintaining and health, preventing and treating the diseases and still there are evidence-based effects of hydrotherapy on various systems of the body that has

not been studied in the field of physical education, especially in case of the neurohormonal system as cortisol, serotonin, and beta-endorphin Maglisho, (2003) Biel (1997), Damjanov, (1996) Gould, (1997). Exercising in water allow to have less stress on the joints, when the water comes up to the neck of the practitioner, the j Introduction:

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*Water Sports Dep. El Arish University.

** athl.training and movement Dep. El Arish University

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water allow to have less stress on the joints; when the water comes up to the neck of the practitioner, the joints are only supporting about 10% of the body weight, as the water:

Points are only supporting about 10% of the body weight, as the water:

- lessens gravity forces on joints.
- improves the range of motion of the joints.
- provide support to move, stretch, walk and
- strengthen both muscles and joints.
- increase the metabolism of the body and.
- help the progress to exercise on the ground, and

the main benefits of aromatherapy can be summarized into points:

- improves muscle strength and tone.
- increases heart, muscle strength.
- increases fitness and endurance.
- decrease swelling and improve blood flow.

- increase range of motion and flexibility (Salvo, 2009).

In general, hydrotherapy affects all body systems positively, such as the muscle-skeletal system, cardiovascular skin, respiratory system, Genitourinary system, and hematology and immunity. In the case of the nervous system, research indicated a reduced amplitude and increased latency and duration of the compound action potential, it also reduced sensory nerve sensation and motor NCV and nerved sensory conduction and also reduction of motor nerves (Hinkle, 1997, Fritz, 1995) except that the effect of hydrotherapy on neurotransmitters of the central nervous system is not well documented in studies and reviews, based on the available literature. So, this study aimed to determine if the effect of a proposed hydrotherapy exercise program on some biological variables of swimmers.

Hypothesis it is hypothesized that the proposed hydrotherapy exercise program might positively affect the biological variables of swimmers.

Materials and Methods:

Research Methods:

The researchers used the experimental method of one practical group of pre-post-measurement due to its suitability to the nature of the study.

Research sample:

The sample was chosen in an intentional manner from the swimmers in clubs of Cairo; they were registered in the Egyptian swimming federation in the season (2019-2020) in three months

periods from 1/6/2019 to 30/8/2019
aged 20.1±2.2 years, height 175.3±5.4,

weight 76.4±4.6 kg.

Table (1)
basic characteristics of the sample

Variables	M	SD	Median	Skewness
Age (y)	20.1	2.2	20	1.23
Height (cm)	175.3	5.4	176	1.05
Weight(kg)	76.4	4.6	77	.54

The sample was composed of 12 swimmers for the main study, 6 for pilots, 2 of the swimmers did not complete the exercise program.

Pilot study

The pilot study was determined using 6 participants from outside the main research. The main objectives of the pilot study were:

- Explain the aim of the study.
- Be sure of the place of the procedure of the study.
- Be sure of the soundness of the types of equipment.
- Beware of the different problems while executing the study.
- Detect the precise time for beginning the study.
- Explain the roles of assistants in the study.
- Registration of the items of each participant

The main results of the pilot study:

- The understanding of the assistant of the procedures.
- Be sure of the soundness of different equipment of the study.
- The understanding of the participants about the procedures of the main study.

Data collection methods:

Using theoretical readings, reference survey international information network, dealing with the research than

to determine the measurement suitable for the study, as follows:

- medical scale to measure weighting (kg).
- restameter for height measure.
- pulse meter for pulse rate detection.
- syringes (5ml, tubes for blood collection, and store spirometer for vital capacity detection.
- centrifuge to detect serum.
- accusport for lactate determination.
- kits specific for cortisol, B-endorphin, serotonin.
- kits specific for IGF,b- FGF , T. protein.
- using Elisa technique for hormones detection and spectrophotometer for T. Protein.
- Aquatherapy exercises: the exercises were arranged as a training program that may affect the different biological changes to improve the physical level of the swimmers.

The hydrotherapy was composed of:

· The overall training program lasted 12 weeks, from 1/6/2019 till 30/8/2019

1st week with moderate intensity 50-74 % three times a week, each composed of warm-up (10 mi), 30 mi per week

Principal training:

General preparation (74 min)

Special preparation (38 min)
 Cooling down (15 min)
 Total time (157 min)
 2nd week intensity 75-89% the same
 practice with total time reach (22 min)
 3rd week intensity 90 -100% the same
 preparation
 Whole time (238 min)
 4th week intensity 50-74%
 Whole time (164 min)
 5th week intensity 75-89%
 The whole time (184 min)
 6th week intensity 90 -100 %
 T. period (208 min)
 7th week intensity 50 – 74 %
 T. period (133)
 8th Week intensity 75 -89 %
 T. period (148 min)
 9th week intensity 90-100%
 T. period (145 min)
 10th week intensity 50-74%
 T. period (109 min)
 11th week intensity 75-89%
 Period (91 min)
 12th week intensity 90-100%
 T. period (114 min).

The basic principle of the proposed hydrotherapy program :

- Detecting of the program aim and its different stages
- Attention to the individual variations
- Detection of the program period and the suitable time for practicing the program
- Graduation from simple to complex
- Using of different training and its continuity
- Flexible exercise program
- Pay attention to the intensity and load and its severity and precision.
- Graduation of the load
- Warming up and cooling down and rest interval as a must exercising in

water allows having less stress on joints, lessen gravity forces on joints improve the range of motion, provide support to let the person move, stretch, walk and strengthen muscles and joints, also help to progress to exercise on land.

Statistical Analysis:

The researchers used the statistical program (SPSS) statistical package for social science.

- standard deviation

- mean

- skewness

- student "t" test for the differences before and after the program Man Whitney

(Wilcoxon Rant Sam test was made for comparison pre-post program.

A level of 0.05 was used to indicate the statistical difference. A P-value less than 0.05 was considered statistically significant.

Results and Discussion:

The data presented in table (2) indicated that the hydrotherapy program led to an increased Serotonin consent ratio. This increased serotonin might stimulate the higher centers of the brain, which induce a synergistic action for cognition memory performance and help power and speed decision due to activity on different portions of the cerebral cortex, thalamus, and limbic system of the brain and the intellectual functions of the brain. This is following the work of Matt Ridley. (2001) and Guyton and Hall (2006). They added that serotonin is formed in the body by hydroxylation, which is related to intelligence and mood stimulation. Chatterjea and Shinde (2006) reported

that the functions of serotonin are diverse from acting as potent vasoconstrictor meaning leading to constriction of blood vessels also produces contraction of smooth muscles, that is, muscles of internal organs and a stimulator of cerebral activity as it stimulates the brain functions and excitations are also of essential to say that deficiency of serotonin produce the depressant effect, and the increased concentration of serotonin affects the mood and wellbeing of the person, they also added that serotonin in the brain is in a compound form, and that drugs like reserpine act to release serotonin from its bound record Guyton and Hall(2006) reported the mechanism action of serotonin on memory facilitation by stimulation of the facilitator presynaptic terminal and its release at the surface of the sensory nerve, also serotonin acts on serotonin receptors in the sensory terminal membrane, the receptors activate the enzyme adenyl inside the membrane, induce formation of (CAMP) and also inside the sensory presynaptic terminal, leading at the end to stimulate memory through the action of the neurotransmitter

serotonin hormone. Table (2) indicated significantly increased levels of b-endorphins after the hydrotherapy program, thus leading to a state of high being among persons as b-endorphins act as a natural opioid without side effects on the person.

This was also recorded by Hatfield (2013), Koch (2003), Lee (2003) added that endorphins are a group of polypeptides that influence

the bind to opioid receptors like morphine and play a role in pain perception, which helps in the continuation of exercise for a longer time without the sensation of pain, which led to storing the activity of a person and induce early fatigue. Thus, endorphins enhance physical performance due to nervous stimulations Rekling et al. (2000) added positive effects of hydrotherapy practicing and the more endorphins secreted for the sake of the athlete, which result from a life full of hope and relaxation, and positive action, also this may help in the continuation and the regularity of exercise effect resulting from its positive action and good impact on the participants and a method of inducing a better mood and living high.

Bielak (2010), Blackmore et al. (2009) reported that hydrotherapy exercises induce an improvement in cognitive function and brain together with the advancement in physical condition and strength reported in the studies.

This agrees with the data study, which indicated in table (2,4) an improvement in neural hormones and growth factors studied (IGF,b-FGF), leading to positive action in neural and physical performance, as also reported by Ross and Leve Ritt (2001), Rodriguez. (2010), who indicated several factors affecting muscle strength.

- Cross-section measure of the muscles.
- The different internal or external causes
- Angles of muscle stretch.

- The direction of the muscle fibers is longitudinally or transverse.
- Type of muscle (white, red) fibers.
- Age and nutrition and rest.
- Genetic.
- The ability of a nervous system to stimulate muscle fibers
- State of the muscle before contraction.
- The synergic of the muscle affects movement.
- The viscosity of the muscle.
- Duration of contraction.
- Psychological factors.

Cortisol is a hormone secreted by the adrenal cortex and has different effects on the body. Stimulate gluconeogenesis, which forms carbohydrates from proteins and other substances.

Decreases glucose utilization: this may help sparing glucose during stress. Elevate blood glucose concentration which may be caused by the two previous functions.

Reduction in cellular protein, which may act as a catabolic agent, increases liver and plasma proteins.

Mobilization of the fatty acid from adipose tissue may shift the metabolic system of the cells from the utilization of glucose for energy to the utilization of fat in times of stress like exercise or starvation.

It also increases obesity and is vital to resist stress and inflammation. It may decrease immunity (Guyton and Hall "2006").

Table (2) revealed that the investigated cortisol hormone was significantly increased in Pre-hydro therapy compared with a post-hydro therapy program; it is well known that

cortisol hormone is a marker of stress, physical or emotion, it is reported to reduce stress to athletes compared to non-athletes when cortisol increased, that means that the responsibility is stressed and an indication of that person can't serve under pressure, work a mild distraction while the lesser the cortisol level at rest is an indication that the person or the athlete in the study is suited to work under stress, as he can tolerate stress and usually work in stress situation and has not hesitated.

This agrees with researchers (Ting-Juetal,2008) (Ganong,2000). Ganong (2000) added that cortisol secretion from the adrenal cortex is stimulated by the action of the adrenocorticotrophic hormone of the pituitary gland by the action of different stressors, including physical, psychological or mental, and emotional ones, and that the secretion of cortisol is essential to prepare the person to fight in stress conditions, as cortisol increased glucose level for the vital organs of the body including the brain because the glucose is the primary nutrient of the nervous system to help in energy production in abnormal situations and different kinds of stress.

Mougios (2006) reported that physical exercises, including hydrotherapy, exercise especially of long duration, increase mitochondria numbers and sizes and increase oxygen supply and retard fatigue and improve fitness. Also, regular exercise increases growth factors such as IGF,b FGF (table3), which stimulates the growth of the muscle fibers, increases muscle mass, induces hypertrophy of the muscle size, and improves strength

fitness. They act as growth promoters affecting the shape, size, weight, and muscle mass of the skeletal muscle due to regular exercises based on the scientific method (Rodriguez et al. 2003).

Many biological effects are produced during hydrotherapy that could affect executive function; the environment in itself affords new stimuli within an enriched environment that in water, the buoyant support that the water provides may increase comfort during therapy, allowing to enjoy the exercise experience. Also, the increase in circulation that augments blood availability may lead to cerebral circulation and neural function. Maintenance of growth of muscles and bones and the sensation of security that the water provides, and the reduction in pain due to endorphins secretion and stimulation by hydrostatic pressure and the offloading of the joints promoted by the upward force of buoyancy. Lastly, a continuation of the aqua exercise is vital for cognitive benefits (Man et al., 2010, Bennell, Hinman 2011).

Table (4) indicated the physiological variables of swimmers' pre-post hydrotherapy exercise program, pulse rate decreased at rest after hydrotherapy, which meant an improved cardiovascular benefit. It is also an indication of improved fitness of the swimmers after the program that reveals a positive result due to the water exercise. It was also under the study of) Brass 2003, My Burgh 2003) (Kaln 2004). Also, the training state of swimmers improved by the dynamics of the heartbeat.

Lactate concentration (Table 4) also decreased after the hydrotherapy exercise program. It is a good indication of the swimmers' fitness and better physical condition because the decreased lactate is a sign of lactate tolerance. The swimmers need training for a more extended period without a sense of pain or fatigue. Many researchers also record this. (Delp and Laughlin 2008, Kraemer et al. 2002).

Vital capacity increased significantly after the hydrotherapy exercise program, as revealed in table (4); this is an indication that aquatic therapy exercise assists in the cardiopulmonary improvement and that the therapeutic exercises may strengthen pulmonary muscles and diaphragm, which in turn help in the advancement of pulmonary function and capacity, this result is in accordance with the studies of (Tschakovs Kian and Hughson 1999) and (Sudip et al. 2006).

Conclusion:

In conclusion, the hydrotherapy induced a list of biological efforts that affect executive function, namely:

Provide support that increases comfort and enjoy the exercise.

Increase circulation that augments blood to the brain, muscles, and bones.

Reduce fatigue and pain due to endorphins, enhance security, and decrease lactate concentration.

Essential for cognitive benefits.

Depress stressors are induced on the body.

Maintain nutrients to the nervous system as glucose for energy production.

Increased fitness of swimmers by vital capacity improvement.
decreased pulse rate and lactate and

Table (2)
serotonin, b-Endorphin, cortisol of swimmers Pre-post hydrotherapy program

Variables	Pre		Post		Sig
	M	SD	M	SD	
Serotonin (NG/ML)	156.3	9.7	264.7	10.9	S
b-Endorphin (PG/ML)	37.6	5.4	69.2	7.1	S
Cortisol (UG/DL)	20.2	3.9	15.2	3.5	S

The values expressed as meant standard deviation $p < 0.05$

Table (3)
IGF, b-FGF, and total protein of swimmers Pre-post hydrotherapy program

Variables	Pre		Post		Sig
	M	SD	M	SD	
IGF (PG/ML)	43.6	4.1	82.6	7.3	S
b-FGF (PG/ML)	25.3	2.3	56.4	5.4	S
Total protein (G/DL)	6.5	1.4	8.3	1.5	S

The values expressed as meant standard deviation $p < 0.05$

Table (4)
physiological variables of swimmers Pre-post hydrotherapy program

Variables	Pre		Post		Sig
	M	SD	M	SD	
Pulse Rate (C.Min)	72.4	4.7	68.1	3.8	S
lactate (MMOL/L)	1.6	0.2	1.1	0.1	S
Vital Capacity (L)	3.7	0.5	4.2	0.6	S

The values expressed as meant standard deviation $p < 0.05$

References:

1. **Bennell K, Hin Man R, (2011):** Review Of Clinical Evidence For Exercise In Osteoarthritis J Sci. Med. In SPORT, 14,4-9.
2. **Bielak A, (2010):** How Can We Not Lose It If We Still Don't Understand How To Use It? Gerontology 56,507.
3. **Biel A, 1997** Trail Guide To The Body. Books Of Discovery.
4. **Blackmore D, Large B, Waters M, (2009):** Exercise Increase Neural Stem Cell In A Growth Dependent Manner Stem Cells, 27,2044.
5. **Brass L, (2003):** Thrombin And Platelet Activation, Chest 124, 188.
6. **Delp M and Laughlin M, (2008):** Regulation Of Skeletal Muscle Perfusion During Exercise. Acta Physiol. Scand. 162, 44.
7. **Damjanov, I., 1996** Pathology For The Health-Related Profession. W. B. Saunders..
8. **Fritz S., 1995** Mosby's Fundamentals Of Therapeutic Massage. Mosby..
9. **Ganong W., (2000):** Medical Physiology A Lange Medical Book, USA.
10. **Guyton A and Hall J, (2006):** Textbook Of Medical Physiology, Elsevier Saunders, USA.
11. **Gould B., 1997** Pathophysiology For The Health Profession. W. B. Saunders..
12. **Hatfield F., (2013):** Fitness The Complete Guide ISSA, Trainer Course, USA.
13. **Hinkle C., 1997** Fundamentals Of Anatomy And Movement. Mosby.
14. **Kaln R, (2004):** Relationship Between Deep Venous Thrombosis And The Post Thrombotic Syndrome, ARCH Intern Med. 164,17.
15. **Koch W., (2003):** Molecular Dissection Of Neuromuscular Junction Trends Neurosc. 26,335.
16. **Kraemer W, Adams K, Cafarwili E, (2002):** Progression Models In Resistance Training, Med. Sci, Sports Exerc. 34,364.
17. **Lee C., (2003):** Mechanism Of Action Of Neuromuscular Blocking Pharmacol Ther 98,143.
18. **Maglisho E, (2003):** Swimming Fastest Human Kinetics.
19. **Man D, Tsang W, Hui C (2010):** Do Older T'aichi Practitioners Have Better Attention And Memory Function J Of Alter. And Compl. Med. 1259.
20. **Matriddle (2001):** Genome Fourth Estate, London.
21. **Moor F., 1997** Manual Of Hydrotherapy And Massage. Mosby.
22. **Mougios V, (2006):** Exercise Biochemistry, Human Kinetics, USA.
23. **Myburgh K, (2003):** What Makes An Endurance Athlete World Class Biochem. Physiol. Mol. Integr Physiol. 136,171.

24. **O'Rourke M.**, 1995 Hydrotherapy And Heliotherapy. Educating Hands.
25. **Rekling J, funk G, Bayliss D, (2000):** Synaptic Control Of Motoneuronal Excitation, *Physiol Rev.* 80, 767.
26. **Rodriguez F, Keskinen K, Malvela M (2003):** Oxygen Uptake Kinetics During Swimming, Univ. STETIENNE Publications, 379.
27. **Rodriguez F, (2010):** Energy Systems In Swimming Nova Science Publication, Inc.
28. **Ross A, Leve Ritt M (2001):** Long Term Metabolic And Muscle Adaptation To Training *Sports Medicine* 31,1063.
29. **Salvo S.**, 2009 *Massage Therapy Principles.* W.B. Saunders.
30. **Sudip S, Dey S, Debnath P, (2006):** Influence Of Specific Training Program On Lung Function Of Young Soccer Players *New Horizons, ICPAFR, Poland.*
31. **Ting-Ju L, china, W., Tzu H, (2008):** The Effect Of Exhausting Exercise On Testosterone, Cortisol In College students And Athletes, *ISHPER-SD Congress, Japan.*
32. **Tschakivski M and Hughson R, (1999):** Factors Determining Oxygen Uptake In Exercise. *JAPPL. Physiol.* 86,1101.