Effects of a Training Program Using Aqua Aerobics on Improving the Functional Status of Individuals with Diabetes

*Dr/ Mohamed Al-Azab Behery

Introduction and Research Problem:

In our modern age, Man has become vulnerable to many diseases including cardiac diseases, atherosclerosis and diabetes, in addition to the effects of stress that lead to metabolic, cardiac, nervous and cardiovascular disorders (7:60).

World Health Organization (WHO) indicates that diabetes is one of the most common diseases all over the world, and especially in developing countries. This particular disease is called "The Secret Killer" as it sneaks to vital organs of the body and destroys it one after another. Therefore, it is considered as one of the most dangerous diseases in this century (23:13).

Diabetes, or "The Secret Killer" as it is called in the Mediterranean Basin, is one of most dangerous and most common diseases all over the world. Recently, efforts for fighting and controlling this disease are initiated under direct command of the International Association for Fighting Diabetes, using successful initiatives in the medical and sports fields (9:72).

It is noteworthy that there are several causes for diabetes including genetics, endocrine diseases, obesity, insulin-secreting cell disorders, drug abuse and stress. From the fourth decade of the human life, the human body begins to deteriorate as vital organs start to weaken due to aging factors. Metabolic and endocrine activities, cardiac pumping, aerobic capacity of lungs, nervous activity and physical fitness decrease significantly (22:87).

Specialists in medical and physical education fields tried to identify causes of diabetes and how to relatively control, prevent and cure it. This joint work led to designing several physical

* Assistant professor, Aquatic Sports Training Dept, Faculty of Physical Education for Men – Alexandria University.

programs that proved effective and positive. These programs were applied inside and outside gyms with various techniques, styles, methods and equipments. Nevertheless, there was a clear lack of using aquatic medium in these programs that aimed at improving the functional status and that had a direct effect on cardio-respiratory systems. Fighting diabetes, or at least decreasing its fatal effects is a medical obligation and may lead to preventing side-effects of this disease.

The American Association of Sports Heart indicates that regular physical training; especially low intensity exercises increase the efficiency of vital systems and therefore play a major role in preventing several chronic diseases, including diabetes. Recently, there is an increased awareness about the importance of aquatic exercises as one of the most recent therapeutic measures for improving the functional status of the human body due to its major role as a branch of alternative medicine.

Aquatic medium is one of the best means for improving physical fitness and for rehabilitation and preventive medicine. The following are some of the benefits of practicing physical exercises in aquatic medium:

- Due to its refreshing nature, aquatic exercises increase the individual's ability to work.
- Decreasing the vulnerability to joint and muscle problems as research on aquatic exercises indicates that this type of activity is more suitable than dry-land exercises for individuals with musculoskeletal problems as weight loads over the lower limbs decrease significantly in water.
- Improving individual performance as aquatic exercises make the individual practice in an agile manner and increase the range of motion
- Aquatic exercises are used as a base for all modern theories and approaches for training methods
- Aquatic exercises can be done in any aquatic environment and are suitable for all age groups
- Aquatic exercises provide physiological, psychological and enjoyment support

- Aquatic exercises increase joint flexibility and muscle stretching in addition to strengthening muscles and joints without being vulnerable to injuries or side-effects through water resistance exercises and gradual weights
- Aquatic exercises represent a means for improving general health and the efficiency of vital systems of the body (12:185)

Medical therapy aims mainly at fixing any disorder that may happen to any vital organ or system of the body that may affect its function through medication. Therefore, the researcher, according to his field of expertise, utilized a set of physical exercises in an aquatic medium with body movements in a try to improve vital efficiency of body systems without interfering with body mechanisms, in addition to compensating any deficiency in these systems' abilities while facing traditional dry-land loads. This program is designed for individuals with diabetes according to each individual's health conditions on a solid base of medical, biological and biomechanical sciences. In addition, the program has a psychological aspect that helps maintaining psychological stability, mental activation, mental productivity and self-confidence so that the individual feels capable of performing his/her daily life tasks and improving his/her productivity.

This research is a directed scientific trial for designing a training program using aqua-aerobic exercises for improving the functional status of individuals with diabetes.

Aims:

The current research aims at:

1. Designing a training program using aqua aerobic exercises for individuals with diabetes
2. Identifying the effects of the training program using aqua aerobic exercises on improving the functional status of individuals with diabetes

Hypothesis:

The training program using aqua aerobic exercises improves the functional status of individuals with diabetes.

Methods:

Approach:

The researcher used the quasi-experimental approach

(two-group design) with pre-/post-measurements.

Research Limits:

- **Geographic:** Prince Abdullah Ben Saud Athletic City – ARAR – KSA
- **Human:** Employees of Northern Borders University and some of the local **inhabitants :** (40-50 years)
- **Time frame:** 3-1-2013 to 29-3-2013

Subjects:

Subjects were purposefully chosen from employees of Northern Borders University and some of the local inhabitants of ARAR – KSA who are diabetic (n=26). Sample members were divided equally into two groups (experimental/control). Sample members were chosen for the following reasons:

- Sedentary subjects
- Having the willing to participate in the program
- All members were under medication (diabetes pills)

Table (1)
Statistical Description of Research Variables (n=26)

Variables	Measurement	Mean	Median	SD	Squewness	Flatness
Age	Year	44.50	45	2.32	-0.13	-0.68
Height	Cm	185.40	185	3.10	0.02	-1.27
Wight	Kg	94.90	95.05	2.05	0.08	-0.34
Blood sugar	Mil.gm	180.53	180.45	2.78	0.23	-0.78
HR_{rest}	BPM	88.81	89	2.48	-0.09	-0.20
HR_{max}	BPM	172.69	173.50	3.58	0.01	-1.66
Endurance duration	Sec	18.53	18.88	3.38	-0.23	-1.06
Recovery after min 2	BPM	151.08	150.50	3.85	0.19	-1.50
Recovery after min 4	BPM	131.81	131	3.68	0.25	-1.20
Recovery after min 6	BPM	117.93	118.56	2.84	-0.18	-1.25

Table (1) indicates that squewness values ranged between (-0.23) and (0.25). These values are between (±3) indicating that sample is free of radical distributions.

Data Collection Tools and Equipments:

Tests:

1. Physical effort on treadmill (3:45)

Measurements:

2. Body weight (kg)
3. Hear rate at rest (HR_{rest}) after wake up in the morning
4. Blood sugar (before breakfast)
5. Heart rate at effort (HR_{max}) immediately after effort and after 2, 4 and 6 minutes

Equipments:

1. Treadmill
2. A digital watch (Polar System) for measuring heart rate
3. A medical balance for measuring weights
4. "ACUECHECK" device for measuring blood sugar
5. Measuring strips for blood sugar
6. Plastic weight (different weights)
7. Dumbles (3kg)

Pre-Measurements:

Pre-measurements were taken on 3/4-1-2013 according to the following protocol:

1. Sample members came to the measurement lab at the faculty before breakfast wearing sports wear.
2. Each subject lied down on his/her back for 15 min for measuring blood sugar using ACUECHECK device. At the end of 15 min period, heart rate at rest (HR_{rest}) was measured
3. After that, body height and weight were measured
4. Physical effort test on treadmill was administered and heart rate after effort (HR_{max}) was measured immediately after the test and then after 2, 4 and 6 minutes.

The recommended Training Program:

Duration:

Through review of literature, the researcher noticed that most similar studies used programs for 8 to 16 weeks. Therefore, the researcher designed the program to be applied for 12 week (3 units per week) with total of 36 training units as shown in table (2).

Table (2)
Timeframe of Training Phases

Phase	Weeks	Units per week	Goals	Target heart rate	Method of training
One	4	3	- General fitness using body weight exercises (strength endurance) - Aerobic exercises	120-140 BPM	Low-intensity interval training
Two	4	3	- Maintaining fitness level of phase one * Maintaining aerobic work - Improving anaerobic work - Improving aerobic/anaerobic work	140-160 BPM	Low-intensity/high-intensity interval training
Three	4	3	- Maintaining fitness level of phases one and two - Maintaining aerobic work - Improving aerobic/anaerobic work - Improving anaerobic work	160-180 BPM	High-intensity interval training

Principles of designing the program:

- Intensity was identified according to heart rate using Carnoven's equation (appendix 3) (18:29)
- Motor exercises are used
- Avoiding exercises that require holding breath
- Exercises are done within the target heart rate of the unit
- Exercises should deal with all body muscle groups
- Training principles (specification – adaptation – gradual loading – individual differences) should be considered
- Punctuality and continuity of training
- Basic exercises should be preceded by warm up and followed by cool down

Application:

The recommended training program was applied to the experimental group from 5-1-2013 to 27-3-2013 (3 units per week) using low-intensity interval training. Each unit consists of:

- Warm up: 10-15 min including swings, stretches and flexibility exercise for all body muscles
- Main part: 30-45 min including aqua aerobic exercises in water
- Cool down: 5-10 min including in-water exercises for recovery of normal heart rate

Post-Measurements:

Post-measurements of both groups were taken on 28/29-3-2013 following the same protocol of pre-measurements.

Results:

Table (3)

Difference Significance between means of pre- measurements of the experimental and control groups on research variables (n1 = n2 = 13)

Variables	Experimental		Control		Means difference	(t)
	Mean	SD	Mean	SD		
Age	45.08	2.50	43.92	2.06	1.15	1.29
Height	185.54	3.15	185.31	3.17	0.23	0.19
Wight	94.98	2.19	94.82	1.99	0.16	0.20
Blood sugar	180.56	2.56	180.49	3,08	0.07	0.06
HR_{rest}	88.85	2.44	88.77	2.62	0.08	0.07
HR_{max}	172.23	3.09	171.31	3.42	0.92	0.72
Endurance duration	18.87	3.44	18.19	3.41	0.68	0.51
Recovery after min 2	151.21	3.77	150.92	4.07	0.31	0.20
Recovery after min 4	131.46	3.67	132.15	3.81	0.69	0.47
Recovery after min 6	117.46	2.93	118.39	2.78	0.93	0.83

(t) table value on (24) (0.05) = 2.07

Table (3) indicates no statistically significant differences between the experimental and control groups on all research variables, as (t) table value was higher than its calculated value on (0.05). This indicates that both groups are equivalent.

Table (4)

Difference Significance between means of pre- and post-measurements of the experimental group on research variables (n = 13)

Variables	Pre-		Post-		Means difference	Difference deviation	(t)	Improvement percentage (%)
	Mean	SD	Mean	SD				
Wight	94.98	2.19	87.98	2.24	7.00	2.21	*11.41	7.96
Blood sugar	180.56	2.56	149.10	4.36	31.46	3.12	*36.36	21.10
HR_{rest}	88.85	2.44	81.23	3.09	7.62	2.53	*10.83	9.38
HR_{max}	172.23	3.09	154.82	4.65	17.38	3.77	*16.60	11.23
Endurance duration	18.87	3.44	24.67	2.38	-5.80	2.77	*7.54	23.50
Recovery after min 2	151.21	3.77	134.85	2.44	16.38	2.69	*21.93	12.15
Recovery after min 4	131.46	3.67	116.00	3.39	15.46	2.90	*19.19	13.33
Recovery after min 6	117.46	2.93	95.69	3.15	21.77	3.09	*25.43	22.75

(t) table value on (12) (0.05) = 2.18

Table (4) indicates statistically significant differences between pre- and post-measurements of the experimental group on all research variables in favor of the post-measurements. Improvement percentage between pre- and post-measurements ranged between 7.96% and 23.5%.

Table (5)

Difference Significance between means of pre- and post-measurements of the control group on research variables (n = 13)

Variables	Pre-		Post-		Means difference	Difference deviation	(t)	Improvement percentage (%)
	Mean	SD	Mean	SD				
Wight	94.82	1.99	95.01	1.92	-0.18	0.87	0.76	0.19
Blood sugar	180.49	3.09	179.79	2,52	0.70	1.10	*2.31	0.39
HR_{rest}	88.77	2.62	88.69	1.84	0.08	2.06	0.14	0.09
HR_{max}	171.31	3.42	171.08	3.48	0.23	1.01	0.82	0.13
Endurance duration	18.19	3.41	18.25	3.47	-0.06	0.34	0.63	0.33
Recovery after min 2	150.92	4.07	151.31	3.68	-0.38	0.96	1.44	0.25
Recovery after min 4	132.15	3.80	131.00	3.65	1.15	3.05	1.36	0.88
Recovery after min 6	118.39	2.78	117.95	2.98	1.09	2.75	1.42	0.92

(t) table value on (12) (0.05) = 2.18

Table (5) indicates no statistically significant differences between pre- and post-measurements of the control group on all research variables except for blood

sugar. Improvement percentage between pre- and post- measurements ranged between 0.09% and 0.92%.

Table (6)
Difference Significance between means of post- measurements of the experimental and control groups on research variables (n1 = n2 = 13)

Variables	Experimental		Control		Means difference	(t)
	Mean	SD	Mean	SD		
Wight	87.98	2.24	94.82	1.99	*7.03	8.57
Blood sugar	149.10	4.36	180.49	3.09	*30.69	21.95
HR_{rest}	81.23	3.09	88.77	2.62	*7.46	7.48
HR_{max}	154.82	4.65	171.31	3.42	*16.23	10.8
Endurance duration	24.67	2.38	18.19	3.41	*6.42	5.50
Recovery after min 2	134.85	2.44	150.92	4.07	*16.46	13.43
Recovery after min 4	116.00	3.39	132.15	3.80	*15.00	10.85
Recovery after min 6	95.69	3.15	118.39	2.78	*21.62	17.98

(t) table value on (24) (0.05) = 2.07

Table (6) indicates statistically significant differences between the experimental and control groups on all research variables, in favor of the experimental group, as (t) calculated value was higher than its table value on (0.05).

Discussion:

1- Blood Sugar:

Table (6) indicates a significant decrease of blood sugar in favor of the experimental group. The researcher thinks that this is due to the effects of using aerobic training in the aqua aerobic exercises. This is consistent with Gleim (1989), Shalaby (1988) and Nour (1995) in that aerobic training decreases body fats and increases energy expenditure in addition to increasing energy consumption during aquatic training. Furthermore, blood sugar decrease is due to the physical effort exerted through aqua aerobic exercises. This effort increases cell sensitivity to insulin which in turn increases its efficiency in the body (8:21) (2:21) (3:115)

Table (5) indicates statistically significant

differences between the pre- and post-measurements of the control group on blood sugar. The researcher thinks that this is due to the punctuality of this group in attending training with special nutrition. On the other hand, there were no statistically significant differences in any of other variables as this group did not use the recommended training program and used only medical therapy.

2- Heart Rate:

Table (6) indicates a significant decrease of heart rate (HR_{rest} and HR_{max}) in favor of the experimental group. The researcher thinks that this is due to the improvement of heart function as the recommended training program included aerobic low-intensity gradual exercises. This is consistent with Kannel et al (1991) in that physical training decreases the sympathetic activity of the heart which in turn increases heart nutrition and decreases mechanical effort exerted (10:86).

3- Endurance Duration:

Table (6) indicates a significant decrease of endurance duration in favor of the experimental group. The researcher thinks that this is due to the effects of the recommended training program which included aerobic exercises that work on improving the efficiency of the cardio-pulmonary system. This is consistent with Consilman (1995), Kies Ling and Lundqvst (1999) and Esawy (1995) in that this type of exercises improve the individual's efficiency in exerting effort for longer durations. This is also consistent with Morgan et al (195) and David (1996) in that exercises performed punctually and continually work on increasing the number of mitochondria in skeletal muscles which in turn works on increasing the production of Adenosine Tri-Phosphate (ATP) that should be reproduced in human muscles to exert effort (12:91) (11:14) (1:13) (14:87) (5:139).

4- Recovery after 2, 4 and 6 minutes:

Table (6) indicates a significant decrease of recovery after 2, 4 and 6 minutes in favor of the experimental group. The researcher thinks that this is due to the effects of the recommended training program which included aerobic

exercises that work on improving the efficiency of the heart making it work more economically. This decrease in heart rate after effort is an indicator of the improvement of physical fitness for the experimental group as returning quickly to normal condition means that the functional status of the central nervous system becomes stable quickly and this means that all vital systems of the body return quickly to normal condition. This is consistent with Robinson (1997), O Brien et al (1997) and Blomqvist (1995) in that quick return of heart rate to normal reflects the good status of vital systems, especially the cardio-pulmonary system that mostly bears the main effort exerted (19:165) (17:73) (4:9)

Body Wight:

Table (6) indicates a significant decrease of body weight in favor of the experimental group. The researcher thinks that this is due to the effects of the recommended training program. This is consistent with Rvotie et al (1994) in that the decrease of body weight indicates oxidation of fats stored in body tissues due to aerobic exercises (20:76)

Conclusions:

The researcher concludes the following:

Diabetic individuals practicing the recommended program for 12 week (3 units per week) along with medical therapy showed significant improvements in their physical and physiological conditions compared to their peer taking only medication.

Improvement percentage for the experimental group ranged between 7.96% (body weight) and 23.5% (endurance duration).

Improvement percentage for the control group ranged between 0.09% (HR_{rest}) and 0.92% (recovery after 6 min)

Recommendations:

The researcher recommends the following:

1- Diabetic individuals should practice the recommended program to improve their physical and physiological conditions and prevent them of any side-effects or risks associated with diabetes.

2- Spreading health education concepts through following the instructions of preventive programs. This can

be achieved through active involvement of media.

3- Strengthening the links among faculties of physical education and other faculties related to the sports activity to produce more multi-disciplinary research works with health-related nature

References:

Arabic References:

1- Al-Esawy, Ahmed A. (1995): Effects of a recommended training program for physical fitness on improving the cardio-pulmonary efficiency in scuba divers. Masters thesis, Faculty of Physical Education for Men – Alexandria University – Egypt

2- Shalaby, Shalaby M. (1988): Effects of a recommended training program on some physiological variables in individuals with diabetes. Journal of Theories and Applications No. 5, Faculty of Physical Education for Men – Alexandria University – Egypt

3- Nour, Modtafa M. (1995): Effects of muscle-nerve coordination exercises on improving the functional and psychological status in individuals with diabetes. Masters thesis, Faculty of Physical Education for Men – Alexandria University – Egypt

English References:

4- Bcomqvistyg, (1995) : The Frank lead exercise, Electrocardiogram, acta .second, 440 (suppl).

5- Bernacki, R. H., & Stager, J. M. (1995):. Swim instruction, training, and assessment apparatus: Google Patents.

6- David R., Fitness and life time commitment Burgess publishing company, Minnesta.

7- fiter giralled (1988) the American environmental movement new York.

8- Glein, G.W., Nicholas J.A., : metabolic costs and heart rate responses to treadmill walking in water at different depth and emperatares, A.M.J of sports med. Vol. 17, No. 2, 1989

9- fiter giralled (1988) the American environmental movement new York

10- Kannel ,W.B., and Dawber, (1991), Therosclerosis & Pediatric Problem . Pediatr . 80

11- Kies Ling and Lundqvst,C.G (1999) Number and Size of Skeletal Muscle Mitochondria inTrained Seden Tary Men . Mallmbrg Baltimore University Park Press.

12- Kannel ,W.B., and Dawber (1991) Therosclerosis as & Pediatric Problem. Pediatr . 8

13- Lamp: physiology of Exercise response and Adaption, New York, 1992

14- Morgan To, Morriss .H.I, (1998), ExercisePhysiology Enery Enery Nutrition and Human Performance 2 nd .ed lea

15- Morriss, H.I.,: exercise physiology energy nutrition and human performance, 2nd. , ed., 1992

16- nikkilMcanton (1988), effect of physical activity on post prandial leeles , lancent , june

17- O,Brien,k.p.,Lawrence (1997), Comparison During Angina Induced By Arrial Pacing . Circulation 39.

18- peter JANSSEN, MD (2001): LACTATE Threshold Training ,Pub.Human Kinetice,U.S.A .

19- Robinson.T.R., (1997), Relation of Heart Rate and Systolic Blood New York . 307

20- Rvoti, R.G., Troup, J.T., Berger, R.A.,: the effects of non swimming water exercise and older adults, J. of orthopaedic, sports physical, vol. 19, no.3, 1994

21- Stein ,marry (1989) cardiovascular disease evaluation and prevention

22- Whitney, J. D. (1988). Imperfect competition and import penetration. Atlantic Economic Journal, 16 (1), 7-18.

23- W.H.O (2005) Health hazards of the human environment .