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# The effect of an isotonic training program on strength of quadriceps muscles in aging

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## ABSTRACT

The purpose of this study was to assessment of the effect of strength training (isotonic) like Nautilus equipment (in water and on land) on quadriceps muscles in knee extension to 45 and 90 degree. 175 older men (50-60 ages) participated in this research that 60 subject selected between them and then divided to three groups: control, training on land and training in water. The subjects volunteer to participate in study. The essential purpose of this research was to assessment of the effect isotonic training on static strength quadriceps muscle and the study about the effect isometric training was performed in the past. Muscle strength was measured by tensiometer (pre test and post test) in the 45 and 90 degree of extension of knee. exercise program included: 3 sessions in a week and for 5 continuous week (15 sessions) and three sets per-session with ten repetition (Mac Kwien). Before beginning any exercise (with Mac Kwien method) subjects performed callisthenics and stretching exercise as warm-up, and consulted with his personal physician before of test program (during tests physician presented). The results from the t test student and ANOVA indicated: 1) Training on the land and in water had significant effect on quadriceps muscle strength extension 45 and 90 degree of the knee and 2) Training on the land had more effect on quadriceps muscle strength on extension of knee joint. The comparison of the water group shows a little increasing in post test phase which is not statistically significant. Our finding suggest that isotonic strength training may also induce central nervous system changes, which can increase the number of motor units recruited, alter motor neuron firing rates, enhance motor unit synchronization during a particular movement pattern and result in the removal of neural inhibition. So we need more studies details about isotonic exercises its effect and its various methods.

**Key words:** Isotonic training, Strength, Quadriceps muscles, Aging.

## INTRODUCTION

It is well known that the aging process is associated with loss of skeletal muscle mass and increase in intramuscular fat, the latter also defined as muscle attenuation [1]. Decline in muscle mass is caused by a general loss of muscle fibers and reduction in cross-sectional area of the surviving fibers, with the fast-twitch fibers showing accelerated muscle atrophy, especially at advanced age [2]. Additionally, qualitative changes occur in the old muscle: specific tension (force normalized to cross-sectional area) of whole muscle and of both type I and type II muscle fibers is lower compared to a younger muscle and maximal shortening velocity is reduced [3].

Taken together, the combined results of quantitative and qualitative muscle changes determine a progressive decline in the overall mechanical muscle function, with muscle power and explosive muscle force declining at a steeper rate than muscle strength [4]. From a functional standpoint, these changes make it progressively harder to carry out daily motor activities (e.g. level walking, chair rising, carrying shopping bags) due to reduced functional capacity and higher relative effort for each motor task [5, 6]. Importantly, although motor performance in general becomes impaired with increasing age, time-constrained and rapid motor tasks (i.e. 200-300 ms duration) such as balance recovery after tripping may become even more challenged for older adults[7].

The relationship between muscle strength and muscle mass is relatively well known and it is primarily related to the number of active sarcomeres in parallel. Although a close association between decline in muscle mass with reduced muscle strength with aging has been identified [8], a disproportionate greater loss of muscle strength compared to muscle mass was recently reported in a longitudinal study (~3% versus~1% per year, respectively) [9]. Importantly, low muscle mass, muscle attenuation and muscle strength have been independently associated with increased risk of mobility limitation, but the association of muscle mass with mobility limitations seems dependent of low muscle strength. Although muscle strength has been recognized as an important predictor for reduced functional performance [10] emerging evidence suggests that muscle power (the product of force time velocity or the rate of performing work) may play a more important role for loss of functional independence, incidence of falling and functional motor performance [11, 12, 13].

Muscle power requires the integration of muscle force with the ability to develop contraction velocity, the latter related to the number of active sarcomeres in series [14, 15].

Thus, although muscle power shares several muscle properties with muscle strength (e.g. physiological muscle cross sectional area), it is influenced by numerous additional neuromuscular properties (e.g. fiber type composition, muscle fiber length, muscle fiber pennation angle, motor unit firing frequency, discharge doublets) [15]. Additionally, muscle

Power seems to be maximized at a specific external resistance [16] that is, maximum muscle power is obtained when muscles contract against a load intensity ranging between ~40 and ~70% of 1Repetition Maximum.

Explosive force (rate of force development, RFD) is intimately linked to muscle power as it determines the magnitude of acceleration in the initial phase of a movement and thereby influence movement velocity [17, 18]. RFD is the most time-dependent mechanical muscle variable, essential for short-lasting movement (e.g. preventing an impending fall) or with movements with limited range of motion (e.g. ankle extension). In older subjects, RFD has been reported to correlate with postural control ability [19] and with poor balance recovery after tripping [20].

Importantly, the association of RFD and muscle power may vary according to the bio-physical determinants of the motor task evaluated (e.g. range of motion, time available for power generation, power-load relationship) [18].

Spinal columns and knees are more vulnerable than other parts of body, because on one hand obesity incur more pressure on these parts and on the other hand surrounding muscular weakness in this joints cause that, this pressure transferred to the joint and bring some difficulties, pain and different damages on this parts [21, 22, 23, 24]. Human body should be used just like any other living organism. Otherwise not only the muscle operation becomes limited, but also its formation changes too, to clarify the point, nothing is more obvious than to say when an organ becomes numb, disabled and weak because of fracture or sprain, not only muscles get weak and thin but also it's bone loses much of it's mineral substances and become hollow [25, 26, 27, 28, 29].

## MATERIALS AND METHODS

Statistical society studied was 175 people of old men (between 50 to 60 years old).At first 45 people were chosen randomly and then they were divided into three equal groups: control, training on land and training in water. All subjects took part in this project with complete satisfaction. Participant's muscular strength in extending knee's degree at 45, 90 angles was tested in two stage of pretest and posttest (by tensiometer). Exercises were done for 15 sessions (5 week, 3 session per week and 3 set in each session) it included 10 repetitions (Mack queen Method). The equipment that has used in this research is confirmed by mechanic engineers group.

At first these people took part in a one- hour session and they were explained how to performance each group separately. Each person's muscular strength would be examined before starting to exercise and appropriate weight will be chosen for exercise. (The heaviest weight that can moved it 10 times in a complete round). Exercises that including 15 sessions are practiced according to Mack queen method and they involved 10 times repetition of 3 set and they will given between the sets for 1-2 minutes. (According to relative activating and rest in interval exercises). The time for resting between sets was 2 minutes at first session, 1.30 minutes at second and 1 minute at third session. ANOVA test, t test student (dependent and independent) and Toki exploring test have used for statistic analysis in orders to  $H_1$  statistic's operations have done  $P < 0/05$  level with use of SPSS software.

## RESULTS

Exercise in water with weight had a sensible on quadriceps strengthen increase in extending knee's joint in 45 and 90 degree. Weight training on land with weight had a significant effect on quadriceps strengthening increase in extending knee's joint in 45 and 90 degree. Weight training on land had more effect on quadriceps muscular strengthening in 45, 90 knee's folded conditions than exercise in water. Unidirectional variance analysis test results for quadriceps muscle pretest and posttest power difference average comparison in 45, 90 angle in their knees in two land and water chosen exercise, indicate that there is a significant difference on  $P < 5\%$  level (table1) for couple comparison of quadriceps muscle power difference average among groups, Toki's exploring test mentioned, and it's result has shown in table2. Toki test result, indicate that pretest- posttest power difference average of quadriceps muscle in 45 degree land exercise group with 45 degree water exercise group and 90 degree land exercise group with 45 degree water exercise has significant difference on  $P < 5\%$  level but other groups doesn't have sensible difference. This matter has shown clearly in 3 tables. Result in 3 tables indicate that muscle power difference average in two water groups in 45 and 90 degree placed in one subset and don't have any significant difference with each other also 90 degree water group quadriceps muscle power different average and two land groups in 45 and 90 degree place in on other subset and don't have significant difference with each other. But results show that there is a significant difference on  $P < 5\%$  level between the first subset groups subset groups. So we concluded that exercise on land in 45 or 90 degree was more practical that exercise in water.

Table 1-Difference average of quadriceps muscle in 45 and 90 angles on two groups of land and water

Changes source	Quadrates average	Degree of Freedom	Quadrates average	F	P
Among groups	15731.60	3	524.86	4.76	0.007
Into groups	39583.40	36	1099.62		
Total	55318	39	1624.48		

Table 2- couple comparison of difference average quadriceps muscle power in the studied group

Groups	Average difference	Standard error	P
90 degree land 45 degree land	-1.80	14.83	0.999
45 degree water	40	14.83	0.050**
90 degree water	37.40	14.83	0.073
45 degree land 90 degree land	1.80	14.83	0.999
45 degree water	41.80	14/83	0.037**
90 degree water	39.20	14.83	0.056
45 degree land 45 degree water	-40	14.83	0.050**
90 degree land	-41.80	14.83	0.037
90 degree water	-2.60	14/83	0.0998
45 degree land 90 degree water	-37.40	14.83	0.073
90 degree land	-39.60	14.83	0.056
45 degree water	2.60	14.83	0.998

\*\* $P < 0/05$ =significant

Table 3-Difference average of similar subsets quadriceps muscle power in the studied groups

Group	Number	Subset
45 degree water	10	41.40
90 degree water	10	44
45 degree land	10	81.40
90 degree land	10	83.20
significant	----	0.056

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**DISCUSSION**

Before and after exercise on land there were significant differences between quadriceps muscle power for extending knee's joint in 45 and 90 degree conditions. That representative power increase in this angle. This increase is due to muscle contractions on resistance and movement is influenced from strong exercise affects, with weight in neural adaptation, connected to involved muscles [30]. Researches in London in 1986 by Roterford and his cooperators in 2011 by Knight and in 1994 in Florida university has done, that all of them, investigated the strong exercise effect on land on the quadriceps muscle that however they had difference in tests and time of informants, but totally is confirmed. The effect of this exercise on quadriceps muscle power increase that has comparison with result of this research.

Before and after exercise on water there were a significant difference between quadriceps muscle power in extending knee's joint in 45 and 90 degree condition. That is representative exercise effect in water on quadriceps muscle power increase. In this research that has done inside country in 2010 by Parsaei effect of exercise in water on quadriceps muscle power increase in extending knee in 30 angles had been meaningful although researched angle had been different. [31] But it is close to this research and its result has the comparison with this investigation. Also the research that have done in out of the country although ways of exercise wasn't same with this research on quadriceps muscle but the results shows that exercise in water is effective on increasing the power of muscles.

Weight training on land has affects more that exercise in water on increasing the quadriceps muscle's power in 45 degree's angle extended knee. This can be related to gravity on land and floating feature of water power in exercised group on land was increased than exercised group in water, and this can be represent of this note that exercises on land has the more increasing in power, the most important cause in comparing it with water can be the existence of gravity power and not being any blocks like water [25]. In researches that have done out of the Rutherford country in 1986. Effect of powerful exercises on the muscles of quadriceps is investigated. Knight considered increasing the power of above muscles by the DARPA technique. Result of the same research that has done in country in 2010 by Parsaei that indicated the effect of powerful exercise in water in 80 degree's folded knee in the girls that were student at university have comparison with the result of this research. Also in 1996 the research has done by the Taxing medical center that was 12 weeks with 24 exercise session in water. Power in quadriceps muscle has 58 percent increases. Although the mentioned research wasn't the same as this one completely. By the way it shows the effect of powerful exercise in water. The result of t test was shown independent that the power increasing on land was more than the power in water; this difference can be because of gravity effect more than water resistance and also the effect of floating in water that causes leg's weight becomes light. In 1993 research about effects of plyometric movements in water and on land was compared that differences between exercised groups in water and on land hadn't observed. In Temple university above research as the aspect of performing the test and comparison doesn't have any harmonistic to this research in 1994 in Atlanta another research is done in order to inside ligament recovery in knee's joint. The groups had compared in power amplification. The result in regain the maximum muscle's ability wasn't affective exercise in water than on land was. That approximately have the harmonistic with the result of this research but there are a lot of difference between kind of exercise and the comparison of abilities in two researches. That can't compare the result of these two researches.

The finds of research shows that isotonic powerful exercise may cause too many changes in central neural system. It takes to use a lot of dynamic units for performing the special dynamic patterns. Anyway we need to study more about isotonic exercise and effect of them and also the different way to use.

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