# THE EFFECT OF THE DIFFERENT GEAR RESISTANCE EXERCISES ON THE MAXIMUM CONSUMPTION OF OXYGEN (VO2MAX) AND THE strength CHARACTERIZED BY SPEED AND TIME OF ACHIEVING (15) KM AGAINST THE CLOCK FOR CYCLISTS

[1]Dr. Alaa Jassim Mkhilf Al-SHihany

*Abstract - This experimental study aims to identify the effect of different resistance exercises by using gears in the maximum consumption of oxygen (Vo2max), the strength characterized by speed, and the time of completing a distance of (15) km against the clock for nascent cyclists. The study included a random sample of (16) nascent cyclists who were participating in the Iraqi league for cycling (2017). The study subjects were randomly divided into study and control groups; each group included eight subjects. The researcher prepared resistance exercises refined by the gears' resistance and the time of achieving determined distances according to the aerobic energy system, via continuous training which was applied for (15) minutes in the final part of the time of the main section of the training session. Such an application was at the rate of two training sessions per training week for a (12) training weeks. The researcher concluded that the resistance exercises of different gears improved the maximum Vo2max, improved the strength characterized by speed for the leg muscles of the cyclists, and improved the time of completing a distance of (15) km against the clock.*

Keywords: Gear resistance exercises; maximum consumption of oxygen; Strength characterized by speed

---

Subject classification codes: include these here if the journal requires them

**Study objectives:**

This study aims to (1) identify the effect of different gear resistance exercises in Vo2max among nascent cyclists, and (2) identify the effect of different gear resistance exercises in the strength characterized by speed, and time of achieving (15) km against the clock for nascent cyclists.

**Research hypotheses:**
(1) There are statistically significant differences in Vo2max and strength characterized by speed, and time of achieving (15) km against the clock between groups over time.
(2) There are statistically significant differences between groups in Vo2max and strength characterized by speed, and time of achieving (15) km against the clock in posttest time.

**Materials and methods:** An experimental pretest-posttest design was used in this study.

*Sample and sampling:*

---

[1] *University Of Al- Mustansiriya*

The target population included the cyclists (N = 22) from five sport clubs in Baghdad City which are Al-Meethaq, Al-Adl, Al-Shabab, Al-Najdah, and Al-Kathimiyah. The accessible population included a random sample of (16) nascent cyclists which constitutes (72.72%) of the target population. The subjects were randomly assigned into two groups; eight subjects were assigned for each of the study and the control groups. The remaining six cyclists were recruited for the pilot study. The study tests were carried out for the period from January 30th, 2016 to April 4th, 2017 on Al-Yousfiyah highway northwestern to Baghdad to Al-Sina'a sport club – Baghdad City.

The researcher worked to homogenize the study sample in some anthropometric variables in the tests used to ensure that they are homogenous, in addition to control the influence of the confounding variables as demonstrated in table (1):

Table 1. Homogeneity test for study subjects in terms of BMI and the chronological and training ages

| Variables | N | Mean | Median | SD | Skewness |
|---|---|---|---|---|---|
| BMI | 16 | 21.38 | 21 | 1.147 | .955 |
| Chronological Age (Years) | 16 | 15.19 | 15 | .75 | .334 |
| Training age (Years) | 16 | 2.63 | 2.5 | .719 | .731 |

By observing table (1), all skewness values range around (± 3) which indicates the homogeneity of the study sample in the variables referred to in the table and that they are within the natural curve.

**Devices and equipment used in the study:**
(1) Questionnaire format for data collection and tests results
(2) Fitmatepro (COSMED), in the Bluetooth
(3) The stationary bike "Life fitness" with the capacity of (9700), Mechanic
(4) Electronic stopwatch type (Sport timer)
(5) Electronic device to measure height and weight unit weight (kg), and (cm) to measure length, type (POU),
(6) Sanitary paper to clean breathing masks.
(7)  A sterile solution (methanol) for breathing masks

Table 2. Studied variables and the corresponding tests

| Variables | Tests |
|---|---|
| Maximum Consumption of Oxygen (VO2max) | Fitmatepro system |
| The strength characterized by speed | Hatching for a maximum distance of (10) seconds |
| Achieving (15) km for nascent cyclists | A test in the track |

*First:* Test for maximum consumption of oxygen (VO2max) (Al Nusairy, 2010).
*Test Objective:*
> Measurement of maximum oxygen consumption (VO2max).
> Devices and tools:
> (1) Fitmate pro system
> (2) The stationary bike "Life fitness" with the capacity of (9700), mechanic with an electronic screen for
monitoring the speed and stability of the resistance of each examiner.
> (3) Disinfectant wipes to clean the respirator masks
> (4) Disinfectant solution for sterilization of respirator masks
> (5) Personal electronic scale (kg) and its parts
> (6) Metal tape to measure the length in (cm) and its parts

**Procedures and Performance Specifications:**
To determine the resistance of a stationary bike, the following equation is followed:
The player's weight (kg); his mass * 0.075 = the required resistance, the result is a degree that is documented on the electronic screen. If the bike contains the revolving resistance button, it is rotated according to the number of degrees extracted from this equation.
Before the test is started, the test operator will clean the VO2max respirator with the disinfectant solution, connect the parts of the Fitmate pro system with each other, fixing the pulse belt on the testee's chest, and installing the Bluetooth in the Fitmate pro.
Next to entering the testee's information into the device, including name, date of birth, gender, height, weight, and selecting the type of required test (VO2max) since the system contains several tests, then fixing the respirator mask tightly by means of its belts and make sure of that the air is not leaking out pf the respirator.
Then, the testee is asked to ride the stationary bike which works with legs and hands pushing. Then, the testee starts to increase his speed gradually. Meanwhile, the examiner begins to control the speed of work on the bike by adjusting the speed and control it from (2.5) to (7) km/hour. Thus, the bike differs from Treadmill in controlling the speed through involving body muscles in the work. The Fitmate Pro contains a small screen with a chart that demonstrates the pulse and (VO2max) with their relative ratios, which are monitored by examiner.

**Conditions:**
> (1) The testee should be in the normal state before the start of the test and identifying his maximum pulse via the equation (220-Age in year) to adjust the load and stabilizing it.
> (2) Attention should be paid to increase the load gradient by controlling the speed and monitoring the testee on arrival of effort exhaustion or according to the request of the testee in his inability to continue.
> (3) Stopping the workout on the stationary bike be through gradually decrease of speed.
> (4) Fitmate pro readings are accepted when the testee reaches (84%) or more of the maximum pulse.

*Registration.*
The Fitmate Pro is given a comprehensive reading tape for the measurements of VO2max.
*Unit of measurement:* ml/kg/min
*Second:* Test of strength characterized by speed for the muscles of the legs (Radhwan, 1998):
*Name of test:* Hopping for maximum distance for (10) seconds.

*The purpose of the test:* Measuring the strength characterized by speed for the legs.

*Tools and devices:* Stopwatch, tape measure.

*Performance description*: The tested cyclist stands on the running field at the starting line and a member of the auxiliary team be beside him, the running leader, whose speed is faster than the speed of the tested. On hearing the start signal, both of them hop on one leg for 10 seconds.

*Recording.* The timing starts from the beginning of the hopping (at the starting line) to the end of the (10) seconds. The completed distance during this time is measured in meter; to the proximal centimeter through a tape measure.

*Third:* The test of completion (15) km against the clock for nascent cyclists.

*Unit of measurement:* minutes and its parts.

**Pilot Study:**

The pilot study was conducted at the site of the implementation of the research experiment on 1/30/2016. The purpose of the pilot study was to identify the obstacles that the researcher could encounter on conducting the main experiment later.

*The Pretest:*

The researcher conducted the pretests to test the maximum consumption of oxygen and the strength characterized by speed of the legs at Al-Sina'a Club on 01/02/2017 on the road to Yusufiya, southwestern to Baghdad on 01/06/2017 for the study and control groups. The conditions of the implementation of these tests including the place, equipment, and tools for the purpose of repeat them in the implementation of posttest. To verify the starting point and ascertain the absence of significant differences between the two groups, the results were statistically managed by using T-test (Table 3):

Table 3. Means, Standard Deviations, T-test for the Pretest between Groups

| Tests | Study Group | | | Control Group | | | T | P-value | Sig. |
|---|---|---|---|---|---|---|---|---|---|
| | N | Mean | SD | N | Mean | SD | | | |
| VO2max | 8 | 46.13 | 2.532 | 8 | 45.25 | 1.832 | 0.792 | 0.442 | NS |
| Strength characterized by speed | 8 | 18.88 | 2.031 | 8 | 20.13 | 2.475 | 1.104 | 0.288 | NS |
| Completion of 15 km | 8 | 42.38 | 1.598 | 8 | 41.75 | 2.605 | 0.578 | 0.572 | NS |

df = 16, Probability level = .05

Table (3) reveals that the two groups are equal and that they are on the same starting point in the pretest results.

**Implementation of the application of exercises contents:**

Despite the precautions that refer to the consideration of the privacy of nascent athletes in the strength training of muscle for many reasons including bone safety and arcing. By such a consideration, resistance exercises; refined by controlling gears resistance and the time of completion of determined distances according to the aerobic energy system by the continuing training method, were prepared. These exercises were applied in the last part of the time of the main section of the training session at the rate of (2) training sessions per one training week for 12 training weeks, which included the following:

(1) Stabilizing the bikes in that its tires be on the gears.

(2) The distance of the race was divided into (5) distances by bike when the bike is stabilized on the gears

(3) Considering the principle of gradation and spikes in increasing the resistance of the roller to take into account the capability of each nascent cyclist.

(4) The resistance here is calculated by an electronic device which gives real measurements in (Newton) through the friction of bike tires with the roller installed on it.

(5) The training alternates between increasing the resistance one time and increase the distance again in another.

(6) The researcher adopted the pulse monitoring by aerobic training for nascent cyclist and not to interfere with the aerobic training.

(7) The trainees have practiced these exercises in a continuous training manner.

(8) Resting between repetitions, moving among groups, and one exercise and another according to the aerobic energy system was considered.

*The posttests*

The posttests were carried out under the same conditions of the pretests to test the maximum consumption of oxygen and the strength characterized by speed for the legs at the Al-Sina'a Sport Club on 04/03/2017, and on the road to Yusufiya; southwest to Baghdad on 04/07/2017 for the study and control groups.

**Statistical Analyses**

Data were analyzed by using The Statistical Package for the Social Science (SPSS) version 24 for windows. The percentage, mean, median, standard deviation, skewness, Independent sample T-test, and Paired-Samples T Test.

**Results:**

The results of the tests of the examined variables in the Pretest and Posttest Times:

Table 4. Mean, standard deviations, T-test value, significance, and statistical significance of the pretest and posttest for the study and control groups

| Tests | | Pretest | | Posttest | | Mean Variance | SD Variance | t | Sig. | Ass. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | | | | |
| VO$_{2max}$ | Study | 46.13 | 2.532 | 51.13 | 0.991 | 5 | 2.563 | 5.517 | 0.001 | Sig. |
| | Control | 45.25 | 1.832 | 46.88 | 1.246 | 1.625 | 1.598 | 2.876 | 0.024 | Sig. |
| Strength characterized by speed | Study | 18.88 | 2.031 | 26.88 | 0.641 | 8 | 2 | 11.314 | 0.000 | Sig. |
| | Control | 20.13 | 2.475 | 21.75 | 1.982 | 1.625 | 0.916 | 5.017 | 0.002 | Sig. |
| Completion of (15) km for nascent cyclists | Study | 42.38 | 1.598 | 36.5 | 0.926 | 5.875 | 2.1 | 7.912 | 0.000 | Sig. |
| | Control | 41.75 | 2.605 | 40.5 | 2.204 | 1.25 | 0.886 | 3.989 | 0.005 | Sig. |

Ass. = Assessment, *n = 8*; df = 7, p-value = .05

Table (4) reveals that the mean and the standard deviation for the study group in the results of the maximum oxygen consumption test (VO2max) was (46.13, + 2.532) in the pretest time and (51.13 +0.991) in the posttest time. The SD of the mean deviation of the differences between the results of the two tests (5, 2.563), the paired-samples t-test value was (5.517), which was significant at p-value = 0.05, df = 7. This indicates the statistical significant difference in favor of the posttest. For the control group, the mean and SD for the pretest time were (45.25 ± 1.832) and (46.88 ± 1.246) for the posttest time. The SD of the differences between the results of the two tests was (1.625, 1.598) and the paired-samples t-test value was (2.876) which was significant at p-value (0.05) at the level of significance (0.05) and the df (7), which indicates the significance of the statistical difference in favor of the results of the post-test.

Concerning the results of the test of strength characterized by speed for the legs, the mean and SD of the study group was (18.88 ± 2.031) in the pretest time and (26.88 +0.641) in the posttest time, the mean deviation of the differences between the results of the two tests was (8, 2), the paired-samples T-test value was (11.314), which was significant at p-value = 0.05. This indicates the statistical significant difference in favor of the posttest. For the control group, the mean and the SD for the pretest time were (20.13 ± 2.475), and (21.75 ± 1.982) for the posttest time, the mean deviation of the differences between the two tests were (1.625, 0.916), the paired-samples t-test value was (5.017), which was significant at p-value = 0.05, df = 7. and the score (0.05) at the level of significance (0.05) and the degree of freedom (7) which indicates the significance of the statistical difference in favor of the results of the posttest time.

Regarding the results of the (15) km test for cyclists, the mean and SD of the study group were (42.38 ± 1.598), and (36.5 ± 0.926) for the posttest time. The mean of deviation of the differences between the results of the two tests was (5.875, 2.1), the paired-samples T-test value was (7.912) which was significant at p-value = 0.05. This indicates the statistical significant difference in favor of the posttest. (41.75, + 2.605). The mean and the SD of the control group were (41.75 ± 2.605) in the pretest time and (40.5 ± 2.204) in the posttest time. The mean deviation of the differences between the results of the two tests were (1.25, 0.886), the value of the paired-samples T-test was (3.989) which was significant at p-value = 0.05. This indicates the statistical significant difference in favor of the posttest.

The results of the tests of the variables between the two groups

Table 5. Mean, standard deviations, T-test value, significance, and statistical significance of the posttest time for the study and control groups

| Tests | Study | | | Control | | | t | Sig. | Ass. |
|---|---|---|---|---|---|---|---|---|---|
| | N | Mean | SD | N | Mean | SD | | | |
| VO2max | 8 | 51.13 | 0.991 | 8 | 46.88 | 1.246 | 7.549 | .000 | Sig. |
| Strength characterized by speed | 8 | 26.88 | 0.641 | 8 | 21.75 | 1.982 | 6.959 | .000 | Sig. |
| Completion of (15) km for nascent cyclists | 8 | 36.5 | 0.926 | 8 | 40.5 | 2.204 | 4.733 | .000 | Sig. |

df = 16, p-value = 0.05

Table (5) reveals that the T-test values of (7,549), (6.959) and (4.733) for the three tests were statistically significant, which indicates the significance of the differences in favor of the study group.

**Discussion:**

Reviewing the results of Table (4) displays that the subjects in each of the study and control groups have an improvement in the values        of the results of the three tests in the posttest time. Reviewing the results of Table (5) demonstrates that subjects in the study group outweighed those in the control group in all the examined variables. This could be attributed to the effect of various gears resistance exercises that helped the nascent cyclists in improving the VO2max. Such an improvement lies in the improvement in the mechanism of the cellular regulation in increasing the efficiency of consumption to meet the requirements of aerobic energy oxidation. This, in turn, is necessary to meet the requirement the speed training to complete the determined distances and the muscular strength with resistors, where their results were noticeable in improving the strength characterized by speed for the legs.

The strength characterized by speed for the legs is a physical ability in which the muscular strength and motor speed of the legs are involved for several times.  The speed training was evident in the neuromuscular alignment of the muscle contraction, and decreasing the internal resistance represented by the viscosity and the accompanied movements that relate to the angles of knee joint to push the leg in the direction that provides the economy of the effort. The strength training represented in the encountering the resistance of the gears by legs, which served to achieve reactions represented by the physiological responses of muscles work and tissues to increase their elasticity. This can help in achieving the best contraction required to encounter external burden represented by training load which consider subjects' particularity. This is supported by improvement in completion time for the nascent cyclists. Abdul-Maqsoud (1997) emphasized that "When a muscle has to perform a stronger contraction, the recall of additional motor units would be the path favored by the nervous system." Furthermore, Hamill (2009) stated that muscle elasticity is determined by the connective tissue of the muscle rather than the muscle fibers.

Moreover, Abdul-Maqsoud (1997) stated that "The level of strength speed depends significantly on the level of motor compatibility ... and the functional capacity of the central nervous system is one of the important determinants of the level of force velocity." Martin (1993) mentioned that "When developing the strength characterized by speed, it is essential to emphasize the kinetic compatibility."  Goldberger and Gurney (2011) believe that "The efficiency of high or rapid skillful performance should be accompanied by muscle efficiency in maximizing the oxygen peak uptake to overcome the oxygen deficit."

Bastouisse (1999) stated that "The efficiency of muscular work is linked to the presence of a high amount of oxygen in the muscles or its transfer from the lungs to the muscles responsible for movement through aerobic and anaerobic interactions."

Abu Al-Ula and Ahmed (2003) stated that "The maximum consumption of oxygen (Vo2max) increases under the influence of muscle strength training, but this increase is not equivalent to what can be achieved by endurance training programs." Furthermore, the relationship between work output, oxygen consumption, and cardiac output is directly related to each other, because muscular work increases oxygen consumption.

**Conclusions:**

(1) The various gear resistance exercises help in improving the maximum consumption of oxygen (Vo2max) among the cyclists.

(2) The different exercises of gear resistance help in developing the strength characterized by speed for the legs of nascent cyclists.

(3)  The various gear resistance exercises help in enhancing the time of completion of a distance of (15) km against the clock among nascent cyclists.

**Recommendations:**

(1) It is necessary to refine the aforementioned exercises by the scientific methods according to the foundations and principles of sports training.

(2) It is necessary to educate the coaches of nascent athletes about the importance of resistance training in accordance with the latest equipment in sports technology.

(3) It is vital to pay more attention to the physiologic tests of technology and high reliability when measuring the maximum consumption of oxygen (Vo2max) among nascent cyclists.

(4) Conducting similar studies among female nascent cyclists with a consideration for their age and gender on resistance training.

## References

Abdel Maqsoud, A. (1997). *Theories of Sports Training Force Training and Physiology*: Cairo, The Book Center for Publishing.

Abul-Al-Ula A, A. & Sayed, A. N. (2003). *Physiology of fitness*, 2nd ed. Cairo, Dar Al-Fikr Al-Arabi, 2003.

Al Nusairi, A. S. (2010). *Guide to the Iraqi Olympic sports academy*, (1).

Bastouisse, A. B. (1999). *Foundations and theories of sports training*. Cairo, Dar al-Fikr Al-Arabi.

Goldberger, M, & Gurney (2011). The effects of direct teaching styles on motor skill acquisition of fifth grade children. *Research Quarterly for Exercise and Sport*.

Hamill, J. & Knutzen, K. M. (2009). *Biomechanical Basis of Human Movement*, 3rd ed, Lippincott Williams & Wilkins, 2009.

Ira Wolinsky & Judy A. Driskell. (2008). *Sports nutrition: Energy metabolism and exercise*. New York, Library of Congress Cataloging.

Martin, K. (1993). *Grund Lagen der Training Slehre*, Teil H,Schoridorf.

Radwan, M. N. (1998). *Methods of measuring physical effort in sports*. (1st ed.), Cairo, Al-Kitab Center for Publishing.