Comparative Effect of Dry Land Aerobic and Strength Exercises In Stroke Parameters and Performance Improvement of Sprinters In Swimming Using Free Style Swim at Haramaya University

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Abstract

Sprinting swimming performance highly depends up on the stroke parameter. In the present study the main objective of this study was to investigate the comparative effect of dry land aerobic exercises versus strength exercises in stroke parameters and performance enhancement of sprinters in swimming using freestyle swim at Haramaya University. The study design was experimental with control group. For this study 30 subjects (age 19-26) were selected through purposive sampling. Among them 9 female and 21 male were there as a study sample. Out of 30 subjects only 28 subjects were able to complete the study. In addition to the regular 3 days per week training, 12 weeks dry land strength and aerobic training program was delivered to the subjects. Pretest and posttest for VO_2 max, press up, broad jump, 12 minutes swimming, critical swimming speed and stroke parameter tests was conducted. The data was analyzed using spss version 20 software package. The level of significance was at 0.05. ANOVA test and post hoc LSD multi comparison was used. The posttest result showed significant difference among the groups ($p \leq 0.05$) in critical swimming speed, 12 minutes swimming, VO_2max, stroke length, speed and broad jump except for stroke rate, and press up ($P>0.05$).
Based on the result and findings dry land aerobic and strength exercises with swimming exercises improves the performance of sprinters by improving the VO_2 max, critical swimming speed, stroke length, 12 minutes swimming and broad jump whereas stroke rate and press up were not improved significantly. The current study concluded that the dry land aerobic and strength exercise have positive effect on sprinting swimming performance.

1. Introduction

Swimming is one of the important sports all around the world. Healthy effects of swimming on the human body have so far been reported by many scientific reports. Since it is an Olympic sport discipline, it is also one of the well-studied areas in sport science (Fernandes *et al.*, 2012).

Swimming is a cyclic form of locomotion in the aquatic environment whereby propulsion is generated to overcome resistive forces. Therefore, the goal for competitive swimmers is to maximize propulsion while minimizing drag, given a finite metabolic capacity (Seifert *et al.*, 2010). Studies have shown that, sports has its

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own distinctive skills, tactics and movement patterns, they all have similar physiological demands such as, high aerobic power, high lactate tolerance and increased anaerobic capacity (Bangsbo, 2000). Exercises to improve maximal muscle strength and maximal aerobic endurance capacity are essential elements for enhancing competitive swimming performance (Aspenes *et al*., 2009). It has been acknowledged that many sports depend heavily upon muscular strength and aerobic enhancement especially at competition level (Leveritt *et al*., 2000). The purpose of swimming training is systematically to bring about specific adaptation in improving performance capacity of swimmers. Several performance capacity of swimmers determining factors are influenced during swimming training. One of this factors is strength. The fact that positive correlation has been discovered between power of swimmers and their swimming performance makes swim instructor trying to accomplish power improvement through strength training (Toussaint and Vervoorn, 1990), (Johns *et al*., 1992), (Sharp *et al*., 1982), (Hirofumi *et al*., 1993).

The second factor that determines swimming performance is aerobic capacity. Aerobic capacity can be enhanced through aerobic training (AT) which comprises several modes of activities that primarily stress the aerobic energy system and produce a number of cardiovascular (CV) and respiratory adaptations that increase endurance. High levels of aerobic fitness are mandatory for endurance athletes such as cyclists, distance runners, triathletes, and swimmers (Ratamess, 2012).

Cardiorespiratory function is critical to the performance of many sports and physical activities, such as long distance running and swimming. In endurance-trained adult athletes, the cardiorespiratory system typically shows evidence of having undergone a series of favorable adaptations which are thought to contribute to performance (Ikaheimo *et al*., 1979). These adaptations include left ventricular (LV) enlargement, chamber wall thickening, an increase in cardiac contractility, an increase in cardiac output (CO), and electrocardiographic changes (Stork *et al*., 1992) (Smith *et al*., 1994), VO_2max is considered to be the best value showing cardiovascular performance and aerobic exercise capacity (Thompson *et al*., 2009). During exercise, oxygen consumption (VO_2) increases depending on the workload. Age, gender, exercise habits and cardiac status are the major factors influencing VO_2max.

1.1. Statement of the Problem

Physical fitness training is mandatory for every sport in this world to earn best performance. Likewise swimming also demand high level of strength to generate power as well as high level of aerobic capacity (cardiovascular endurance) to perform long. Aerobic and strength are very important to improve stroke parameter and performance enhancement among swimmers.

However the main emphasis was given on this issue. With this in mind the research was done to fine out “Comparative Effect of dry land Aerobic Exercises and Strength Exercises in stroke parameters and Performance improvement of sprinters in swimming using Freestyle swim at Haramaya University.

Therefore following research questions were answered

1. Which one is more important from dry land aerobic exercises and strength exercises for swimmers to improve their stroke parameters?
2. To what extent the overall performance of swimmers will be affected by regular dry land aerobic exercise versus strength exercise?
3. How far the stroke parameters of freestyle swimming will be improved by the regular dry land strength exercises?

1.2. Significance of the Study

Finding of this study will help Haramaya University swimmers team in particular in creating awareness about the importance of dry land aerobic and strength training in enhancing swimming stroke parameters, swimming performance efficiency. Moreover

- It will help to judge which one is more important for swimmers either dry land strength or aerobic training in improving performance efficiency.
- It will give direction on the values of strength training and aerobic training in stroke parameter of swimming.

1.3. Objectives of the Study

1.3.1. General Objective

The general objective of this study was to examine the Comparative Effect of 12 weeks dry land Aerobic and Strength Exercises in stroke parameters and Performance improvement of sprinters in swimming using Freestyle swim.

1.3.2. Specific Objectives

Specific objectives:-

- To examine the effect of regular dry land aerobic exercises versus strength exercises in improving the stroke parameters of swimmers
- To evaluate and compare the extent to which the overall performance of swimmers will be changed through regular dry land aerobic exercises versus strength exercises
- To assess the changes in stroke parameters of swimmers like stroke rate, stroke length and speed that can be improve by using regular aerobic exercises versus strength exercise.

2. Literature Review

2.1. Relativity of Strength and Aerobic Exercise to Swimming Performance

A combined intervention of strength and endurance training is common practice in elite swimming training, but the scientific evidence is scarce. The influences between strength and endurance training have been investigated in other sports but the findings are scattered. Some state the interventions are negative to each other, some state there is no negative relationship and some find bisected and supplementary benefits from the combination when training is applied appropriately (Aspenes *et al*., 2009). Still different studies show positive correlations between aerobic dry land performances is essential and highly associated with the swimming performance. Results indicated that there was a strong association between the performance of professional swimmers and that of aerobic dry land performance, where the VO_2 max was found to be positively correlated to the swimming performance (Sandhu *et al*., 2012).

2.2. Importance of Strength Training to Swimming

Dry-land strength training aims to increase maximal power outputs through an overload of the muscles used in swimming (Tanaka *et al*., 1993) and it may enhance swimming technique (Maglischo, 2003). If these two points of view are correct, then the increase of muscular strength would improve swimming performance.

Strength training elicits numerous benefits, which include: increased muscular strength, increased tensile strength of tendinous and ligamentous structures, improved joint stability and range of motion, which influences articulation.

2.3. Strength Training to Improve Swimming Performance

Analogous to sprinting speed, which is an interaction of stride frequency and stride length, swimming speed is a product of stroke rate (SR) and distance per stroke cycle (DPS) (Stone, 1990). Sprinters engage in high intensity resistance training, which includes loads lifted at near maximal weights and/or high velocities to improve rate of force development (RFD), which influences stride frequency. Swimmers, likewise, can improve their stroke rate, by increasing their body's force output through resistance training. Studies involving plyometric training have noted improvements in tumble turns, (Cossor *et al*., 1999) dives, and more explosive starts (Bishop *et al*., 2009). Both land-based and water-based plyometric exercises have been proven effective in increasing power output (Robinson *et al*., 2004). In addition to plyometric training, post activation potentiation (PAP), which involves a movement performed at a higher intensity preceding a movement conducted at a lower intensity, has been postulated to improve a swimmer's start performance (Kilduff *et al*., 2011). Although research has suggested that PAP training may elicit improved motor performance (Hodgson *et al*., 2005).

2.4. Strength Training Programming Considerations

Swimmers desiring increased performance and longevity, should engage in a variation of strength training program that emphasizes the stabilization of lumbo-pelvic-hip complex, strengthens the lateral rotators of the shoulder, and the musculature that surrounds the knee capsule. Most exercises in a swimmer's program should consist of compound exercises which, by definition, recruit one or more large muscle groups and involve two or more primary joints, requiring greater stability demands. Consequently, they have considerably more carryover to sport. Compound exercises include: rows, presses, squats, and may be performed bilaterally to recruit more motor units, or unilaterally, to evoke increased stabilization. The remainder of the exercises should be comprised of corrective exercise, such as site-specific isolation exercises, to individually target weaker muscle groups. Dynamic warm-ups, to improve joint mobility and static stretches, to restore muscles back to their resting lengths, following exercise, should also be employed. (Giandonato, 2011).

2.5. Demands Imposed on the Lung by Exercise

Exercise places huge demands on the lung. First, the lung is faced with large changes in oxygenation (PvO_2 declining to 20 mm Hg) and carbon dioxide ($PvCO_2$ rising to 75 mm Hg), as the locomotors muscles use oxygen and produce carbon dioxide. Second, because of a rising Q, the lung has a greatly reduced time to equilibrate the deoxygenated mixed venous blood with the alveolar gas in order to maintain PaO_2 and Pa CO_2 near resting levels. Third, the lung is the only organ that receives all of the blood pumped from the heart and, thus, must accommodate the entire increase in cardiac output during exercise (Farrell *et al*., 2012).

2.6. Importance of Aerobics Training to Swimming

Important physiological changes those are responsible for improving aerobic metabolism. First, point is a reduction in the rate of lactic acid production when swimming at sub maximal speeds. This is due to an increase in the oxygen supply to muscles. That increase is brought about by respiratory, circulatory and muscular changes that increase (A) open alveoli (B) pulmonary diffusing capacity (C) stroke volume (D) the capillaries around muscles, (F) blood volume (F) total hemoglobin (G) the size and number of mitochondria in muscles. Second, is an increase in the quantity of glycogen stored in swimming muscles and the amount can nearly double in well-trained athletes. Third, are an increase in the activity of enzymes of aerobic metabolism and finally, an increase in the rate of removal of lactic acid from swimming muscles (Maglischo, 1997).

2.7. Adaptations to Endurance Training

There are several marked adaptations associated with the regular performance of endurance training. Aerobic endurance training produces increases in VO_2max (Hickson *et al*., 1981, Holloszy and Coyle, 1984, and Rosiello *et al*., 1987) but has no hypertrophy effect on muscle (Hickson *et al*., 1988). Muscle fiber size has actually been shown to decrease (Sale, 1992, and Kraemer *et al*., 1995). Capillary supply to the muscles has been shown to change in response to endurance training through an increase in the capillary to muscle fiber ratio (Hoppeler *et al.,* 1985, andTesch, 1992). There is an increase in the number as well as the size of mitochondria, the latter of which is associated with an increase in certain enzymes (Holloszy, and Coyle, 1984). These increases are most apparent in the type I fibers as they have the highest content of mitochondria. Smaller increases in muscle and blood lactate levels are produced at the same relative exercise intensity after completing an endurance training program (Hickson *et al*., 1981, and Holloszy and Coyle, 1984). Glycogen is depleted less rapidly when trained than when untrained (Holloszy, and Coyle, 1984). The decreased use of carbohydrate during sub maximal exercise is compensated for by a proportional increase in fat oxidation (Holloszy, and Coyle, 1984, Hoppeler *et al.,* 1985). There is also a decrease in heart rate response during sub maximal exercise (Hickson *et al*., 1981). Several of these adaptations are in direct contrast to those associated with strength training.

2.8. Adaptations to Strength Training

Effective strength training programs create muscle hypertrophy which is due to an increase in myofibrillar protein content (Tesch, 1992). This hypertrophy is often associated significantly with that of the fast twitch (FT) and slow twitch (ST) fiber types. Strength training produces certain neuromuscular adaptations (Sale, 1992). These adaptive changes are associated with the coordination of the agonist, synergists, and antagonists (sale, 1992). It has also been shown that mitochondrial volume density decreases as muscle mass increases (MacDougall *et al*., 1979). In contrast to aerobic endurance training there is a decrease in capillary density, within muscle, from strength training which emphasizes high-load, low-repetition exercises (Tesch, 1992). Strength training at moderately high loads with greater repetitions may cause an increase in absolute capillarisation but increases in hypertrophy will result in a maintained or decreased capillary density (Tesch, 1992). There has been some evidence from studies on animals that suggests an increase in the number of vesicles which store acetylcholine in the neuron's terminal (Kraemer *et al*., 1995). A greater force production by the associated motor unit would result if the increase in the number vesicles also corresponds to an increase in the secretion of acetylcholine (Kraemer *et al*., 1995).

3. Materials and Methods

3.1. Experimental Site

The research was conducted in Haramaya University main campus. Haramaya University (formerly known as Alemaya University) is one of the oldest Universities in Ethiopia. Geographically the study area is located approximately 505 km East of Addis Ababa 5 km away from city Alemaya, a town in the Misraq Hararghe Zone, about 17 kilometers from the city of Harar and 40 kilometers from Dire Dawa. Specifically, it is found in Misraq Hararghe Zone, Alemaya (9.4250° N latitude and 42.0333° E longitude) (www.haramaya.edu.et, 2013).

3.2. Experimental Design

In this study experimental design with control group was used. Total three groups were created. Among them two groups were formed as experimental group and the remaining was control group. Pre-test of performance and physical fitness field tests were taken from all groups based on the standard testing protocol.

After this three months training program was delivered in addition to their regular swimming training to the experimental groups with two independent treatments which were strength and aerobics. The training program was given for 12 weeks 3 days per week for the duration of 90 minutes.

3.5. Study Population

Study population of this research was Haramaya University undergraduate students from year 1 to graduating class. Anyone who is able to swim freestyle was included under the study.

3.6. Sampling Size and Sampling Techniques

Purposive sampling technique was used to specify study subjects i.e. a group of swimmers were picked from the whole study population. Swimming coaches were assigned to assess their technique of freestyle. Then 30 students were selected from the population. Finally, using systematic randomization technique they were assigned to the three groups which were aerobic group, strength group and control group. In each group 7 males and 3 females were assigned.

3.7. Inclusion and Exclusion Criteria

Swimmers who were students of Haramaya University without any health problems and injury were included. Athletes with some sort of addiction to drugs were not part of the study. Students with age less than 19 years and more than 26 years were excluded from the study. In short athletes with different factor that affect their performance were excluded. Physical activity readiness questionnaire was used to include and exclude subjects.

3.8. Data Collection Instrument

The whole data collection was performed more of quantitatively and objectively, including field and swimming pool performance test results. The use of these principal data collection instruments were intends to explore a range of quantitative information. Performance test were stroke rate, stroke counts, stroke length and speed were designed to assess the efficiency of swimmer in swimming pool based on testing procedure.Side to side to the swimming performance efficiency test physical fitness such as aerobic capacity (VO_2 max), strength (press up), and standing long jump were used.

3.9. Method and Procedures of Data Collection

Both swimming pool based and dry land based experimental field test were used in both cases pretest and posttest experimental tests. Up on starting the training programs, pre exercise test were made.Then after the intervention posttest was taken in similar fashion to pretest.

3.9.1. Swimming Pool Based Tests for Swimmers

3.9.1.1. Critical Swim Speed Test

Swimming velocity is the product of stroke length and stroke rate. (Tanaka *et al*., 1993; Trappe and Pearson, 1994; (Girold *et al*., 2007). The Critical Swim Speed (CSS) test, devised by Ginn in 1993, was used to monitor the athlete's aerobic capacity. The result of the test was used to determine the appropriate target time for each repetition of a swimmer's aerobic training session. CSS is defined as "the maximum swimming speed that can theoretically be maintained continuously without exhaustion" just below the swimmer's lactate threshold. The test comprises of two maximal swims over 400 meters and 50 meters (Mackenzien, 2005). A suitable rest period was given between each swim to allow the athlete to fully recover. The assistant was recording the times for each swim of all the athletes.

Calculation of CSS

CSS= (D2 –D1) / (T2 – T1)

Where D1 = 50, D2 = 400, T1 = time for 50m in seconds and T2 = time for 400m in seconds.

3.9.1.2. The 12-Minute Swim Test

The 12 minutes swim test for assessing cardiovascular endurance was expressed in terms of distance covered by the athlete, which is similar to cooper 12 minute running test for assessing endurance for athletes.

3.9.1.3. Swimming stroke parameter test

Procedure

*Athletes were allowed to swim from 400-600 meter after dry land based warming up.

* The test was composed of three different 25 meter swim.

* As swimming kinematics is devised to measure stroke rate, stroke length and velocity. For this test 5 athletes of the same group were released at the same time to make some competition in between and help them to use all their maximum effort.

* Timing was started immediately when the athletes cross the five meter flag and was stopped when they cross five meter flags to the wall.

* Assistants recorded the time and stroke cycles for each athlete in separate sheet.

* Athletes were given five minutes recovery time in between each consecutive tests.

*the test was repeated 3 time for every athlete.

Calculations

Stroke length (SL) = distance/ stroke cycle= ------- M/stroke cycle

Stroke rate (SR) = stroke cycle/time = ----------- stroke cycle/second

Velocity (V) = displacement / time OR SL X SR

3.9.2. Dry land based physical fitness tests for swimmers

3.9.2.1. Maximum oxygen consumption test (Cooper VO_2max Test)

The objective of the Cooper test was to measure an athlete's approximate VO_2max.

Procedure

* the 400 meter track was marked in to 100 meter sections to make it easy for calculation of the final distance they will cover because it is not expected to make all full laps by the end of 12 minutes.

* Athletes had warming up before the test is conducted.

* Athletes were instructed to run for 12 minutes to cover the longer distance they can.

* Assistance recorded distance cover by athletes.

* From the distance covered VO_2 max was calculated as fellow.

VO_2max = (Distance covered in meters – 504.9) / 44.73(Mackenzie, 2005).

3.9.2.2 Standing Long Jump Test

This test was used to monitor the development of the athlete's elastic leg strength.

Procedure

*The start of the jump was from a static position.

*The athletes placed their feet over the edge of the land pit.

*The athlete were guided to crouch, lean forward, swing their arm backward, and jumps horizontally as far as possible, considering jumping with both feet into the sandpit.

*The coach will measure from the edge of the sandpit to the nearest point of contact and record the distance in meter.

3.9.2.3. Press-ups Test

The objective of this test was to assess the strength endurance of athlete's upper body muscles.

Procedure

The press-ups test was conducted as follows:

*athletes were lying on the mat, hands shoulder width apart & fully extend the arms

*then lowered the body until the elbows reach 90°

* returned to the starting position with the arms fully extended

*The feet were not be held

*The press up action was continue without rest

*the athlete tried to complete as many press-ups as possible

*the assistance counted and record the total number of full body press-ups.

Female athletes tend to have less relative strength in the upper body and therefore they were allowed to use the modified press up position to assess their upper body strength endurance. The test was performed as follows:

*Laid on the mat, hands shoulder width apart, bent knee position & fully extend the arms

*Then lowered their body until the elbows reach 90°

*returned to the starting position with the arms fully extended

*The feet will not be held

*The press up action continued without rest

*the athletes were tried to complete as many press-ups as possible

*the assistance counted and record the total number of full body press-ups until exhaustion.

3.10. Data Quality Control

Data quality control procedures for stroke parameters of swimming are extremely important and in order to decrease common errors in stroke parameters great emphasis and care was taken on the start of the swimming, timing and stroke cycle counting and recording. In addition to this only standard procedure for obtaining the measurements were used to gather the data from the subjects.

3.11. Methods of Data Analysis

Different Data analyzing techniques was used to analyze and interpret the data which was collected through swimming pool based performance test and dry land based physical fitness before and after the intervention. Some of the parameters with standard norm used in the fitness and swimming performance were compared to the pre-test and post-test results to draw conclusion. Calculations and interpretations of data was carried in two parts. First part was calculations concerning physical fitness changes and part two was concerning stroke parameter comparison. Advanced inferential statistics which is Analysis of variance (ANOVA) was used to see the effect of strength plus swimming and aerobic training plus swimming and swimming only exercise (control) on physical fitness particular strength and VO_2 max. Post hoc LSD Multi comparison was used to compare the effect of strength plus swimming, aerobic plus swimming, and swimming only up on the stroke parameters and speed. All statistical calculations were carried out using SPSS package version 20. The level of significance was at 0.05%.

3.12. Ethical Consideration for Training

This study deals with the ethical issues related to the investigation. The privacy of the participants was protected. Therefore, the study was conducted according to Haramaya University rules, regulations, policies and codes of ethics relating to research ethics.

4. Results and Discussions

Exercises to improve maximal muscle strength and maximal aerobic endurance capacity are essential elements for enhancing competitive swimming performance (Aspenes *et al.,* 2009). It has been acknowledged that many sports depend heavily upon muscular strength and aerobic enhancement especially at competition level (Leveritt *et al.,* 1993), with swimming being of no exception, reinforcing the need to ascertain the existence of an apparent correlation. Strength and endurance training have been performed concurrently in an attempt to improve performance in particular sports (Bell *et al.*, 1991, 1997) and military tasks (Kraemer *et al.*, 1995) as well as for rehabilitation from injury and cardiovascular disease (McCartney *et al.*, 1991). Strength parameters have been recently proposed as one of the multi-factorial phenomenon that enhances swimming performance (Tanaka *et al.*, 1993; Barbosa *et al.*, 2010).

5.1. The effect of the aerobic plus swimming, strength plus swimming and swimming exercise on critical swimming speed

As analysis of variance Table 1 showed that there was no significant difference between the groups at the initial level. But the posttest results showed that there was significance difference between the groups. This was due to the training program in which they were engaged in.

Table 1: **Pre, posttest mean and mean difference value for critical swimming speed.**

Test	Aerobic group	strength group	control group	F value	P-value	LSD
PRT	0.8978	0.8967	0.941	0.392	0.680	NS
PST	1.9011	1.1789	1.0040	89.707*	0.000	0.147
MD	1.0033	0.2822	0.063			

PRT= pre training /test/, PST= post training MD= mean difference LSD= least significant difference *Significant, NS= not significant, SIG= significance value

As indicated in table 1, the pretest mean value was 0.8978 m/sec, 0.8967 m/sec and 0.9410 m/sec for the aerobic plus swimming, strength plus swimming and swimming group respectively. But after the training program in which they were engaged in, the improvement was observed. The posttest means value was recorded as 1.9011 m/sec for aerobic plus swimming, 1.1789 m/sec for strength plus swimming and 1.0040 m/sec for swimming group.

The mean difference between the pre and posttest was 1.0033 m/sec for the aerobic plus swimming group, 0.2822 m/sec for the strength plus swimming group and 0.063 m/sec for the swimming group. To find out which training program was better, pair wise mean comparison analysis was done by using least significant difference at 0.05%.The pair wise mean comparison analysis showed that there was significant difference between the posttest mean. Since, the posttest mean difference value was greater than the required value of LSD at the level of 0.05% for aerobic plus swimming and strength plus swimming group whereas for the control group the LSD values was less than the required value.

This indicates that aerobic plus swimming exercises affects more critical swimming speed than the strength plus swimming and swimming only. The result was consistent with the finding of Maclaren and Coulson, 1999 and Dekerle, 2006 who reported that aerobic training has a positive effect on critical speed in swimming. The change in critical swimming speed showed that the improvement in aerobic capacity.

5.2. The effect of the aerobic plus swimming, strength plus swimming and swimming exercise on 12 minute swimming

Table 2: Pre, posttest mean and mean difference value for 12 minutes swimming

Test	Aerobic group	strength group	control group	F value	P-value	LSD
PRT	356.0	383.33	385.8	0.835	0.446	NS
PST	512.33	413.22	445.2	14.101*	0.000	39.282
MD	156.33	29.89	59.4			

PRT= pre training /test/, PST= post training MD= mean difference LSD= least significant difference *Significant, NS= not significant, SIG= significance value

As suggested in table 2, that there was no significance difference in between the groups at the initial level. But the posttest result showed that there was significance difference this was due to the training program in which they were engaged in for 12 weeks. The pretest means for the aerobic plus swimming, strength plus swimming and control group was 356 m, 383.33 m, and 385.8 m respectively, but after training the groups showed improvement and their posttest mean was 512.33 m for aerobic plus swimming, 413.22 m for the strength plus swimming and 445.2 m for the control group. The mean difference between pre and posttest was 156.33 m for aerobic plus swimming, 29.89 m for the strength plus swimming group and 59.4 m for control group. Furthermore, the pretest mean values was compared to the 12 minutes swimming test norm and based on the norms table all groups were under the category of poor rank 365-456 m. But after the training program the participants of aerobic group advanced by two ranks to reach fair rank 457-548 m. On the other hand the strength plus swimming and swimming group remained in the poor rank.

5.3. The effect of the aerobic plus swimming, strength plus swimming and swimming on the VO_2max

This result of this parameters showed that at initial level there was no significant difference as the calculated F value for pretest was less than required F value, but after twelve week of training program the significant difference existed Table 3 among aerobic plus swimming, strength plus swimming and swimming group participants.

Table 3, Pre, posttest mean and mean difference value for VO_2max

Test	Aerobic Group	Strength Group	Control Group	F Value	P-Value	LSD
PRT	31.18	35.81	29.95	2.14	0. 138	NS
PST	47.19	41.64	35.88	11.54*	0.000	LSD
MD	16.01	5.83	5.93			

PRT= pre training /test/, PST= post training MD= mean difference LSD= least significant difference *Significant, NS= not significant, SIG= significance value

The pretest mean for VO_2max was 31.18 ml/kg.min, 35.81 ml/kg.min and 29.95 ml/kg.min for aerobic plus swimming, for strength plus swimming, and for the control group. After the training the mean values was recorded as 47.19 ml/kg.min, 41.64 ml/kg.min and 35.88 ml/kg.min for the aerobic plus swimming, strength plus swimming and control group respectively. The change between the pretest and posttest illustrates the presence of improvement among the groups by 16.01 ml/kg.min for the aerobic, 5.83 ml/kg/min for the strength and 5.93 ml/kg.min for the control group. The mean differences between the groups showed that improvement after the training. The posttest calculated LSD mean value was greater than the required LSD (4.978) value. The difference in-between the group was recorded as 5.55 for aerobic and strength group, 11.312 for the aerobic and control group and 5.762 for strength and control group. The LSD pair wise comparison indicates all the three groups improve significantly but more improvement was observed in aerobic plus swimming group. Based on the illustration of table 3, all groups pretest and posttest mean values of VO_2 max was compared to the norm table.

The aerobic plus swimming group and the control group pretest mean was in the range 29.0-32.9 ml/kg/min labeled as fair, and the strength plus swimming was in the rage 33.0-36.9 ml/kg/min labeled as good. But after 12 weeks training, the posttest mean value of aerobics plus swimming and the strength plus swimming reached superior label > 41.0 ml/kg/min and the control group reached 33.0-36.9 ml/kg/min. The result of the current study was in agreement with El Mohamady (2012). In his research he found that basic endurance training brought a positive change in maximum oxygen consumption. Furthermore, study conducted by (Obert *et al.*, 1992) discovered a statistically significant correlation between VO_2max and swimming performance in 200- and 400-meter freestyle.

5.4. The effect of the aerobic plus swimming, strength plus swimming and swimming on the press up and broad jump

Table 4, Pre, post mean and mean difference value for press up and broad jump

SV		Aerobic Group	Strength Group	Control Group	F Value	P - Value	L SD
Press up	PRT	27.78	20.00	23.50	1.34	0.279	NS
	PST	31.56	39.78	25.80	2.783	0.081	NS
	MD	3.78	9.78	2.30			
Broad jump	PRT	176.12	171.78	183.1	0.97	0.39	NS
	PST	190.78	214.89	181.5	4.92*	0.016	12.6
	MD	14.66	43.11	-1.6			

PRT= pre training /test/, PST= post training MD= mean difference LSD= least significant difference, NS= not significant, SIG= significance value, S.V= source of variance Table 4, showed the mean difference between pre and posttest for the press up. The pretest mean was recorded as 3.78, 19.78 and 2.3 for aerobic plus swimming, strength plus swimming, and swimming group respectively. The posttest mean values were 31.56, 39.78, and 25.80 for the aerobic plus swimming, strength plus swimming and control group. The posttest mean values showed that there was improvement in the performance. Likewise table 4 revealed the pretest and posttest mean for the broad jump. The pretest mean value for aerobic plus swimming group was 176.12 cm, for the strength plus swimming was 171.78cm and for control group 183.1 cm. The posttest mean value was 190.78cm for the aerobic plus swimming, 214.89 cm for strength plus swimming, and 181.50 cm for the control group. The mean differences between pretest and posttest were 14.66 cm for the aerobic plus swimming, 43.11 cm for the strength plus swimming, and -1.6 cm for the control group. Since the $P \leq 0.05$ in the posttest result of the broad jump this indicates there was significance difference due to the 12 weeks training. After significance change was confirmed by the analysis variance the LSD pair wise comparison was carried out. The calculated LSD for the mean value difference among the strength and aerobic group, strength and control group was greater than the required LSD (12.55) value whereas the mean value difference among the aerobic and control group was 9.20 which was less than require LSD value. The pair wise analysis indicated that the broad jump was more improved by strength plus swimming and aerobic plus swimming than swimming.

5.5. The effect of the aerobic plus swimming, strength plus swimming and swimming on the stroke parameter

Table 5, Pre, posttest mean and mean difference value for stroke parameters

SV	Aerobic Group	Strength Group	Control Group	F value	P value	LSD
PRT Stroke Rate	1.121	0.966	0.985	1.17	0.325	NS
PST	0.889	0.874	0.89	0.015	0.175	NS
MD	-0.232	-0.092	-0.095			
PRT	0.701	0.7	0.71	0.14	0.87	NS
Stroke Length						
PST	1.39	1.084	0.86	29.8*	0.00	0.14
MD	0.687	0.384	0.15			
PRT Speed	0.793	0.675	0.706	0.97	0.32	NS
PST	1.218	0.938	0.768	4.92*	0.02	0.24
MD	0.425		0.263		0.062	

PRT= pre training /test/, PST= post training MD= mean difference LSD= least significant difference, NS= not significant, SIG= significance value, S.V= source of variance

As indicated in table 5 that there was no significant difference among the groups. Table 5, revealed that the posttest stroke rate for all groups showed reduction since the pretest and posttest mean difference value was negative -0.232 , -0.092, and -0.095 for the aerobic plus swimming, strength plus swimming and control group respectively. Its mean the training does not brought any positive change between the groups on the stroke rate.

In case of the stroke length there was no significant difference initially between all groups. But after the training the significant difference existed. On the other hand the posttest and pretest mean values differences showed that there was improvement. The mean values differences among the groups were recorded as 0.687, 0.384, and 0.154 for the aerobic plus swimming, strength plus swimming and control group respectively. The multi comparison post hoc LSD analysis results support the idea that there was improvement after 3 months training. The aerobic plus swimming exercise affects more in the stroke length than the strength plus swimming and swimming group.

In case of speed revealed in table 5, there was no significant difference at initial level. But after the 12 weeks training the difference was recorded. The mean comparison between the pretest and posttest strengthen the idea that improvement was recorded following the 3 month training. Mean difference between the pre and posttest observed and was recorded as 0.443, 0.263, and 0.062 for the aerobic plus swimming, strength plus swimming, and control group. Similarly there was mean value difference between the groups. The difference was recorded as 0.163 for aerobic plus swimming and strength plus swimming, 0.364 for the aerobic plus swimming and control group, 0.201 was the difference between the strength plus swimming and control group. To perform comparison between the groups the post hoc LSD comparison was performed. The aerobic plus swimming group was the most affect as suggested by the post hoc LSD multi comparison. Over all, the table 5 indicated that aerobic plus swimming, strength plus swimming and swimming only was not significant over the stroke rate parameter where as both aerobic plus swimming and strength plus swimming was significantly improve in terms of the stroke length parameter and speed. The current study was in agreement with studies conducted by (Obert *et al*., 1992) they discovered a statistically significant correlation between VO_2max and swimming speed in 200- and 400-meter freestyle. In another study which involved only female swimmers, the same authors discovered that VO_2max has a statistically significant effect on the results of the 400m freestyle.

Concerning the effects of strength training programs for swimming performance enhancement, few experiments were performed. In one of the initiate conducted experiments, (Strass, 1988) in adult swimmers detected improvements of 20 to 40% on muscle strength after a strength program using free weights. These improvements corresponded to a significant 4.4 to 2.1% increase in speed over 25 and 50 m freestyle, respectively.

5. Summary, Conclusions and Recommendations

5.1. SUMMARY

The research tried to assess the comparative effect of dry land aerobic exercise and strength exercise up on the stroke parameter and performance of sprinter in swimming using a freestyle swim at Haramaya University. Aerobic plus swimming group improved in terms of their endurance like 12 minutes swimming test critical swimming speed and VO_2max than strength plus swimming and swimming only group. But in terms of strength and power like press up and broad jump the strength plus swimming improved better than the aerobic plus swimming and the control group. Even though the swimming only group managed improvement but still they are the least improved among aerobic plus swimming and strength plus swimming group. Aerobic plus swimming group earned the greatest change in the critical swimming speed, VO_2max, 12 minutes swimming test and stroke parameter (stroke length, speed and stroke rate) and their swimming performance over the 50m and 400 meter. Strength plus swimming group second best improved group in case of stroke parameters (stroke length, speed and stroke rate), and performance over 50m and 400m and best improved in the press up and broad jump test. Over all the results from the analysis of variance of before and after training for the VO_2max, 12 minutes swimming, critical swimming speed, press up, broad jump indicated improvement in performance of the sprinter. Likewise the results of stroke parameter (stroke length, stroke rate, and speed) indicated that aerobic and strength dry land exercise has positive effect on the performance of sprinters.

5.2 Conclusions

Based on the finding of this study, the following points were stated as the conclusion

- Dry land strength and aerobic exercises have effect on improving the performance of sprinter over the distance of 50m and 400m.
- VO_2max, 12 minutes swimming and critical swimming speed in terms of physical fitness was

affected most and also stroke rate, stroke length and speed over 50m and 400m.

- Press up, broad jump in terms of physical fitness and stroke length, stroke rate and speed over 50m and 400m was affected more by the dry land strength plus swimming.
- Regular dry land aerobic and strength exercise plus swimming can have a positive effect on the stroke parameter (stroke rate, stroke length, and speed) as well as performance efficiency over 50m and 400m. (sprinting swimming)
- Performing dry land strength and aerobic physical exercise improve sprinting swimming performance over 50 m and 400m, and stroke parameter (stroke rate, stroke length and speed) by improving the total body strength and endurance of swimming athletes.

5.3. Recommendations

The finding of this study proved that aerobic plus swimming has brought much better performance improvement than strength plus swimming and control group in all selected variables. Based on the results and findings as well as discussion of the study, the following recommendations are made.

- ✓ Coaches who are trying to improve the stroke parameter of sprinters in swimming to improve the performance of athletes need to include the dry land aerobic and strength exercises in to their swimming training program beyond their routine pool exercises
- ✓ Sport professional working in preparing swimming training manuals, books and leaflet need to provide more information about how dry land aerobic exercise and strength exercises can affect the performance of sprinter as well as the stroke parameters
- ✓ Swimming coach, professionals, and expertise of swimming need to encourage athletes to work hard with this dry land aerobic and strength exercise in order to bring a positive performance improvement

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