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EFFECT OF DRY LAND STRENGTH TRAINING ON FRONT- CRAWL SWIMMING PERFORMANCE AMONG UNDERGRADUATE TRAINEES OF LEAD CITY UNIVERSITY, IBADAN, NIGERIA

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ABSTRACT: *Swimming performance is a multi-factorial phenomenon involving energetic, biomechanics, hydrodynamics, and anthropometrics and strength parameters. Strength, endurance and speed are major factors determining performance of swimmers. Muscle power output is also an important issue in sport performance; it is also a reliable predictor of swim speed in front-crawl performance. Therefore, different training methods have been devised to improve performance. Several studies have been done on swimming performance but little effort has been directed towards improving performance using dry land as a tool. Therefore, this study investigated the effect of dry land strength training on front-crawl swimming performance among undergraduate trainees of Lead City University, Ibadan, Nigeria. Pretest-posttest/control group experimental research design using 2x2x3 factorial matrix was used for this study. Twenty two participants were used for the study using total enumeration sampling method. The participants were placed into two groups; experimental and control group. Participants were exposed to eight weeks training using the manual developed by the researcher. Data were collected before and after the intervention programme. Data was analysed using both descriptive and inferential statistics. The descriptive statistics used were frequency count and simple percentage while Analysis of Covariance (ANCOVA) was the inferential statistics used to determine the main as well as the interaction effects of the independent, dependent and moderating variables.Participants were male and female with a mean age of 19.6±1.7. There was significant main effect of treatment ($F_{(1, 20)}$ =20.217; partial η^2=.822) and gender ($F_{(1, 20)}$ =10.773; partial η^2=.366) on swimming performance of swimmers in Lead City University, Ibadan. Participant in experimental group obtained a lower posttest mean (10.649) than control (13.972). There was significant interaction effect of treatment and gender ($F_{(1, 20)}$ =64.907; partial η^2=.671), treatment and body weight ($F_{(1, 19)}$ =16.394; partial η^2=.222). There was no significant main effect of body weight and the interaction effect of gender and body weight was also not significant. There was significant 3-way interaction effect of treatment, gender and body weight ($F_{(2, 19)}$ =52.099; partial η^2=.471). Dry-land training was effective on swimming performance among swimmers. It was therefore recommended that there is need for swimming coaches to be educated on the benefits of using dry-land exercises to improve swimming performance.*

KEY WORDS: dry-land, performance, body weight, strength, endurance and speed.

INTRODUCTION

Swimming is one of the most popular sports both at competitive and recreational level with varied distance events in butterfly, front crawl, backstroke, breaststroke, free style and individual medley. It is an individual and team sport that requires the use of the arm and legs to move the body through water. It involves self-propulsion of a person through fresh or salt water usually for recreation, sport, exercise or survival. Locomotion is achieved though coordinated movement of the limbs, the body or both. Babalola (2014) states that good performance is of great importance in competitive swimming.

Swimming performance requires swimmers to cover the event distance in the shortest time where the outcome of a race can ultimately be decided by fractions of a second. Success can be attributed to the differences in biomechanical, physiological and anthropometric factors and subsequently the ability of a swimmer to repetitively overcome the resistance of the water in an efficient manner and produce effective starts and turns swimmers are often classified as overhead athletes as they tend to suffer similar injuries. However, the sport of swimming is very different from other sports due to training in a prone position and use of both arms and legs for propulsion, with 90% of the propulsive force supplied by the upper extremities (Aspenes and Karlsen, 2012). Another main difference is that land-based sports use the ground as a reference point of movement, while swimming does not involve ground contact. Therefore, swimmers must use their core as the reference point of movement, which reinforces the need for swimmers to have a strong core to be successful in the sport (Fig, 2015).

Power training has the potential to develop muscle strength under dynamic conditions. Power represents the ability to perform movements at high speed or the possibility of exerting high strength in a short period of time. The relationship between the power, strength and speed of muscle contraction was first described by Hill more than sixty years ago (1938). Swimming performance is a multi-factorial phenomenon involving energetic, biomechanics, hydrodynamics, anthropometrics and strength parameters (Barbosa, Batalha, Raimundo, Tomas-Carus and Silva, 2013). Strength and speed are major factors determining performance of swimmers (Trappe and Pearson, 1994). Scientists and coaches agree that training should include both land and water training sessions. Strength and endurance training in swimming takes place both on land and in the water. Several studies showed that a combination of strength and endurance training inhibit strength and power development (Abernethy and Quigley, 2003; Hennessey and Watson, 2004). Muscle strength is one of the most important motor qualities, which largely influences both the speed of execution of movements and the activities that require strength and skill.

Muscle strength can be defined as the ability of a muscle or muscle groups to voluntarily produce force or a couple against external resistance, under specific conditions defined by muscle action, speed of movement and posture (Miller, 2012). Maximum muscle strength is the possibility to voluntarily produce maximal force or an external resistance couple under specific conditions defined by muscle action, speed of movement and posture (Gavin, 2012). Muscle strength is a fundamental property of human performance that provides important information on human performance by evaluating the effects of training. This can be defined

as the ability to overcome internal and external resistance by muscle contraction. (Tudor, 2002).
A number of studies have found a positive relationship between strength, power and swimming performance. For example, Keiner, Yaghobi, Sander, Wirth and Hartmann, (2015) investigated the influence of maximal strength performance on sprint swimming performances in male and female youth swimmers (17.5 ± 2.0 years) and found there to be strong negative correlations between leg strength (1 RM squat), speed-strength and swim performance particularly for short distances (up to 25 m). They also found a correlation between the strength tests of the upper body and swim performance.

The authors therefore concluded that maximal strength of both the upper and lower body can be good predictors of swim performance. Within a similar age group (17.9 ± 2.9 years), an eleven week combined strength and endurance training program was found to have a significant effect on 400 m freestyle performance, tethered swim force and maximal strength (Aspenes, Kjendlie, HoffandHelgerud, 2017). Similar findings have also been found in international male swimmers where lower body strength and power were significantly related to 'time to 15 m', at the start of a 50 m freestyle maximum effort thus highlighting the importance of strength and power to performance (West, Owen, Cunningham, Cook and Kilduff, 2017).

However, strength gains have not always been found to be associated with an improved swimming performance. Garrido, Marinho, Reis, van den Tillaar, Costa, (2010) investigated the effect of combined dry-land strength and aerobic training in young swimmers over an 8-week period. The main findings suggest that strength training did not improve sprint performance but the authors acknowledge there was trend towards a greater performance improvement in the experimental group over the control group in both 25 m and 50m freestyle. Furthermore, within a group of male intercollegiate swimmers, an 8-week resistance training program improved strength but not swimming performance with the authors suggesting that this may be due to the specificity of training used within the dry-land program (Tanaka, Costill, Thomas, Fink and Widrick, 2013). In addition to whole body strength and power, core stability is recognized as an important determinant of successful swimming performance. The core provides a reference point for all movement in the water due to there being no base of support. The ability to maintain posture, balance and alignment in the water can be key to minimizing drag and ensuring propulsive forces are generated more effectively. Conversely, lack of core stability can lead to legs dropping or unnecessary lateral movement of the legs and hips causing an increase in drag.

In the sport of swimming, the body is actually pulled over the arms of the swimmer, with the pectoralis major, latissimusdorsi and triceps brachii as the primary movers. Due to the dominance of the pectoralis major and latissimusdorsi, swimmers tend to have increased adduction and internal rotation strength. Factor this with the large amount of swim distances performed over the course of a year, an over development of anterior shoulder musculature may occur, thereby creating a strength imbalance with posterior shoulder musculature. Specifically, decreased lower trapezius and serratus anterior strength may account for impaired scapulohumeral rhythm. With increased fatigue and decreased force output, the inability to stabilize the scapula against the thoracic cage causes further scapular upward rotation (Blanch, 2017). Literature also links an imbalance between the internal and external shoulder rotators and shoulder pain in swimmers (Batalha, Raimundo, Tomas-Carus, Barbosa and Silva 2013).

Weak scapular stabilizing muscles might cause a loss of proximal stability that would increase demands on the rotator cuff and perhaps contribute to faulty stroke mechanics, and ultimately, shoulder pain. Numerous studies have reported that the internal rotator musculature is stronger in swimmers because of the repetitive concentric contractions required during the propulsive phase of the swim stroke (Batalha et al., 2013; Swanik, Swanik, Lephart and Huxel, 2017).

In contrast, external rotator strength is consistently weaker in swimmers and literature states that the high eccentric demands placed on the external rotator muscles cause chronic fatigue making it difficult to control glenohumeral-joint translation (Straub and Mattacola, 2014). As a swim season progresses, there is evidence that suggests an increase of muscular imbalances in the shoulder rotators of young swimmers, largely due to increased levels of internal rotator strength and endurance that are larger than those of the external rotators. An increase in joint flexibility is desired in order for the swimmer to achieve greater range of motion during an arm stroke. However, since the glenoid fossa is relatively shallow, excessive glenohumeral joint laxity can lead to future injury if the labrum, ligaments and muscles are not adequately stabilizing the joint (Heinlein and Cosgarea, 2017). Therefore, a balance is necessary between upper extremity muscle strength and flexibility in hopes of reducing shoulder pain. If a balance between the anterior and posterior musculature is not present, a tightness of the posterior capsule can result. As a result the swimmer may present with decreased range of motion of the shoulder internal rotators and adductors as they have increased strength and are overdeveloped (Hibberd, Oyama, Spang, Prentice and Myers, 2017). As the internal rotators and adductors are shortened, the shoulder external rotators and abductors tend to be overstretched and weak secondary to compensation. Blanch (2017) noted that swimmers will attempt to compensate and alter their swimming mechanics secondary to the imbalance in shoulder range of motion.

The high frequency and training of swimming can often lead to shoulder overuse injuries, or what Kennedy and Hawkin's originally described in 1978 as "swimmer's shoulder"(Hibberd, Oyama, Spang, Prentice and Myers, 2017). Research has reported that swimmers believe moderate shoulder pain is a normal part of swimming and that seventy-three percent of adolescent swimmers use pain medication to manage their shoulder pain (Hibberd and Myers, 2013). Some authors opined that the contributing factors in swimmer's shoulder are a swimmer's stroke technique, fatigue, practice habits (yardage, intensity, training methods) and physical characteristics of the athlete (Virag, Hibberd, Oyama, Padua, and Myers, 2014). Those unique characteristics of each athlete can be a combination of muscular strength imbalance, impaired muscular flexibility, joint laxity, altered scapular kinematics and poor posture, all of which have effects on the overall performance of the swimmer.

In order to decrease a swimmer's risk of swimmer's shoulder, an injury prevention program must be made to address strength imbalances, impaired range of motion and flexibility. Exercises aimed to strengthen the weak and lengthened muscles, while stretching the shortened shoulder muscles, have been reported to reduce the risk of shoulder impingement in front crawl (Lynch, Thigpen, Mihalik, Prentice and Padua, 2017). Specifically, isolated stretches of the pectoralis minor, pectoralis major, posterior capsule and latissimus dorsi which are included in a dry land exercise program may be of great value (Tate, Turner, Knab, Jorgensen, Strittmatter and Michener 2017). Dry-land training aims to increase maximal power outputs through an overload of the muscles used in swimming and it may enhance swimming technique. In addition, scapular stabilizers, such as serratus anterior, lower trapezius and subscapularis muscles, external rotators and core musculature must be strengthened in order to have the endurance to cover the high yardage these athletes swim especially in front crawls (Batalha et al., 2013; Johnson,Gauvin and Fredericson,2013). Dry-land training allows to create an efficient swimmer, without injuries, who is capable of adapting to any stress and competition conditions; the aim is to better train the human body out of the water to be effective in the water environment (Gambeta, 2012). Appropriate Resistance Training (RT) may have performance-enhancing and injury-reducing benefits in youth athletes. The awareness of such benefits is demonstrated by an increasing number of swimming coaches working with different age groups that incorporate dry-land training, into their swimming program. Although RT is associated with increased strength, power production and the rate of force development the exact effects of dry-land training interventions on swimming performance, particularly in youth swimmers is unclear.

To swim front crawl effectively, individuals must coordinate a number of complex body movements to maximise propulsion and minimise resistance. During each stroke cycle, swimmers alternate their left and right arm actions, maintain horizontal alignment while rolling about their longitudinal axis to either side (to facilitate breathing) and use a varying number of alternating kicks. Much of the extant literature on front crawl has focused on the arm action, while the contribution of the leg kick to performance has received much less attention. This is not surprising given that the hand and forearm are seen as the major propelling surfaces responsible for >85% of the total propulsion in able-bodied front crawl swimming (Toussaint & Beek, 2016). The leg kick, however, serves several important functions. In front crawl, the leg kick acts to stabilise body roll, helps to streamline the body (Gourgoulis,Boli, Aggeloussis, Toubekis, Antoniou, Kasimatis and Mavromatis,2014), generates propulsion (Sanders &Psycharakis, 2017) and enhances the effectiveness of the arm stroke (Deschodt, Arsac, & Rouard, 2016). There is agreement that maximal swimming speed during full stroke front crawl is reduced by ~10% when swimming with the arms only (Gourgoulis et al., 2014). It is likely that the leg kick ensures ongoing propulsion during the phases when the arm stroke is non propulsive. This would enable a swimmer to travel further down the pool with each arm stroke compared with swimming with the arms alone (Deschodt et al., 2016).

Currently, there is conflicting research on the effects of a dry land intervention program on glenohumeral muscle strength and swim performance (Aspenes & Karlsen, 2012). Therefore, the purpose of this study is to examine the effects of eight week dry land intervention program on swimming performance of swimmers in Lead City University, Ibadan.

Statement of the Problem

Swimming performance is a multi-factorial phenomenon involving energetic, biomechanics, hydrodynamics, anthropometrics and strength parameters. Strength, endurance and speed are major factors determining performance of swimmers. Muscle power output is a critical issue in sport performance. Power is a reliable predictor of swim speed in front crawl skill and it is considered an important practical issue in swimming. To this reason, different training methods have been devised to improve performance. Conventional swimming training is a common and regular practice among athlete swimmers which had been observed to have little effect on muscle strength development and endurance capacity of athletes thus necessitating another means of improving performance in swimming.

A preliminary observation by the researcher revealed that in the last private University games, Lead City University swimmers had speed as they lead up to half of the races in swimming but their speed usually decreases in the middle of the event and at the end of the swimming races were not able to claim any medal. Therefore the researcher was of the opinion that if the swimmer's endurance and strength could be worked upon, their is a possibility that they will perform better. Dry land training is a specialized strength training program, that utilizes a range of resistive loads and a variety of training modalities designed to enhance health, fitness, muscle-strength endurance and sports performance.

Due to the importance of strength, endurance, power and core stability to overall swimming performance and the level of research conducted using a mixed-sex group of adolescent swimmers, the aim of this study is to investigate the effect of an 8-week dry-land resistance training program on swimming performance of swimmers in Lead City University, Ibadan.

Research questions

The study provided answers to the following questions:

1. What is the injury rate of Lead City University undergraduate swimming trainees?
2. Do Lead City University undergraduate swimming trainees use dry land strength training to improve on their front crawl performance?

Hypotheses

The following hypotheses were tested in the study

1. There will be no significant main effect of dry land training on swimming performance of swimmers in Lead City University, Ibadan.
2. There will be no significant main effect of gender on swimming performance of swimmers in Lead City University, Ibadan.
3. There will be no significant main effect of total body weight on swimming performance of swimmers in Lead City University, Ibadan.
4. There will be no significant interaction effect of treatment and gender on swimming performance of swimmers in Lead City University, Ibadan.
5. There will be no significant interaction effect of treatment and total body weight on swimming performance of swimmers in Lead City University, Ibadan.
6. There will be no significant interaction effect of gender and total body weight on swimming performance of swimmers in Lead City University, Ibadan.
7. There will be no significant 3-way interaction effect of treatment, gender and total body weight on swimming performance of swimmers in Lead City University, Ibadan.

METHODOLOGY

The study adopted a pre-test post-test control group experimental research design as it allowed the researcher to match the participants in the experimental and control group on similar variables as well as allowed to see the final difference in the outcome measured in the study which can be attributed to only the effect of the intervention or training given. This design allow researchers to introduce a new intervention to experimental group and takes measurement for both before and after the intervention to establish the effect observed between them and the control group. The design is schematically represented thus:

O_1X_1 O_3 ----Experimental group 1 (Dry land strength training)

O_2 X_2 O_4 ---- Control group

Where O_1 and O_2 are pre-test observations for the experimental and control groups respectively.

O_3 and O_4 are post-test observations for the experimental and control groups respectively.

X_1 Treatment programme (Dry land strength training)

X_2 Control (Conventional swimming exercises)

The population for this study was all undergraduate swimming trainees in Lead City University, Ibadan, Oyo State, Nigeria.

Sample and sampling techniques
The sample for this study was twenty two undergraduate swimming trainees. Total enumeration technique was used, that is all the undergraduate swimming trainees in Lead City University were used for this study. The participants were randomly assigned into two groups. Eleven (11) participants were in experimental group and eleven (11) were in control group.

Research instruments
1. Swimming pool: it was used for swimming
2. Whistle: This was used to draw attention of athletes to moderations when to start and when to stop during training.
3. Stop watch: This was used to time participants during training and performance.
4. Scoring sheets and pen: Scoring sheets was used to record scores of tests of participants while pen was used to write values scored into the scoring sheets.
5. Medicine ball: This was used to perform dry land training
6. Skipping rope: This was used for strength training
7. Bench: This is what the participants lied on to simulate arm and leg action.
8. Swimming trunk: This is wears for the participants during swimming.
9. Weighing Scale: This was used to measure the body weight of the participant.
10. Stadiometer: This was used to measure the height of the participant.
11. Kettle bell: this was used for arm strength training.

Validity and Reliability of Instruments
Validity is the ability of an instrument to measure what it is supposed to measure. It is also the ability of test results to reflect accurately the parameters being measured. Kerlinger and Lee (2000) refers to validity as the extent to which a concept, conclusion or measurement is well founded and corresponds accurately to the real world. Therefore, for an accurate test to be obtained, a test instrument must be valid. To ensure validity, standardized scientific instruments were used for this study. The researcher and his supervisor endeavored to cross-check the calibration and workability of the instruments before use.

Reliability of an instrument is the degree of consistency between two sets of scores or observations obtained with the same instrument. Shuttle worth (2009) refers to reliability as the repeatability and consistency of a test. Acta (2017) recorded a reliability coefficient of 0.97 for the stop watch.

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Test Location:
The location of this study was the Lead City University swimming pool, Lead City University Sports Complex

Procedure for Data Collection
A letter of introduction was collected from the Head of Department of Human Kinetics and Health Education, University of Ibadan for the purpose of identification. The consent of the Head of Department of sports, kinesiology and Health Education as well as that of Director of Sport, Lead City University, Ibadan were also sought. After this the Swithout any form of cohesion. The purpose of the study and the possible risks involved in the tests were explained to the participants. Only the participants who signed the inform consent form were allowed to participate in the study.

Training Program:
The intervention group participated in regularly scheduled swim practice as well as engaged in the eight week dry land strength training. The control group only participated in the regularly scheduled swim practice without engaging in the eight week dry land intervention program. The intervention group completed the dry-land intervention which consisted of two stretches and six strengthening exercises which addressed the shoulder stabilizers and core muscles. The stretches were targeted at the posterior capsule and pectoralis muscles. The strengthening exercises were targeted at the shoulder external rotators, serratus anterior, lower trapezius and core musculature. The intervention was performed 3 days a week for 8 weeks before swimmers entered the pool for practice. The researcher with the research assistants supervised the intervention for a total of 60min. per session. Pre-test score was taken before the commencement of the intervention on both control and experimental group. After the intervention, post test score were taken on both groups as well. Swimming performance was measured using time of finishing. Participants in both groups were made to swim 20m front crawl and the time of finishing was recorded. The recorded time for pretest and posttest were analysed.

Procedure for Data Analysis
Descriptive statistics of frequency counts and percentages were used to analyse the demographic data and research questions while inferential statistics of Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

RESULTS AND DISCUSSION OF FINDINGS

Discussion of findings is divided into three (3) sections. Section A presented the demographic information of the participants, section B presented the answers to research questions while section C provided the result of the tested hypotheses.

Section A: Demographic Information of the participants

Table 1: Distribution of participants by gender

Sex	Frequency	Percent
Male	14	63.6
Female	8	36.4
Total	22	100.0

The table above shows the distribution of participants by sex. The table revealed that 14 (63.6%) were male while 8 (36.4%) were female. This shows that majority of the participants were male.

Table 2: Distribution of participants by age

Age	Frequency	Percent
16-18years	2	9.1
19-21years	13	59.1
22years and above	7	31.8
Total	22	100.0

The table above shows the distribution of participants by age. The table revealed that 2 (9.1%) were between 16 and 18years, 13 (59.1%) were between the ages of 19 and 21years, while 7 (31.8%) were 22years and above, showing that majority of the participants were between the ages of 19 and 21year.

Section B

Research question one: What is the injury rate of lead city university undergraduate swimming trainees

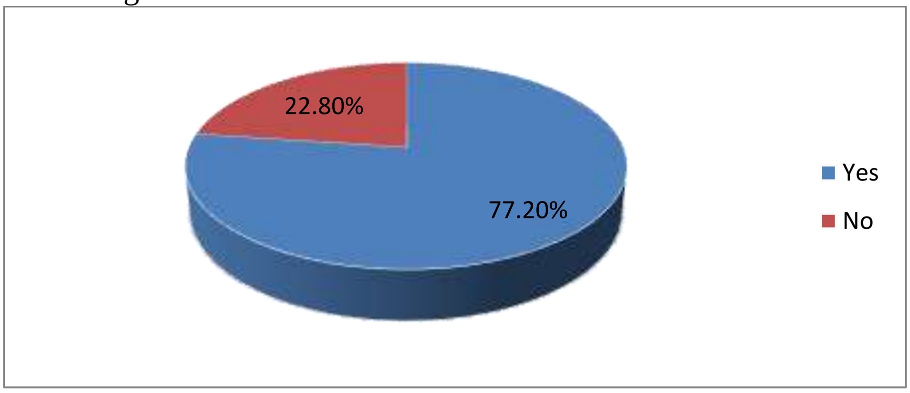

Fig. 1: Pie chart showing rate of injury among lead city university undergraduate swimming trainees

The figure above revealed the rate of injury among lead city university undergraduate swimming trainees. The chart shows that 17 (77.2%) have sustained injury before while 5 (22.8%) had never sustained any injury while swimming. This shows that majority of the participants have sustained injury before while swimming.

Research question two: Do Lead City University undergraduate swimming trainees take to land strength training

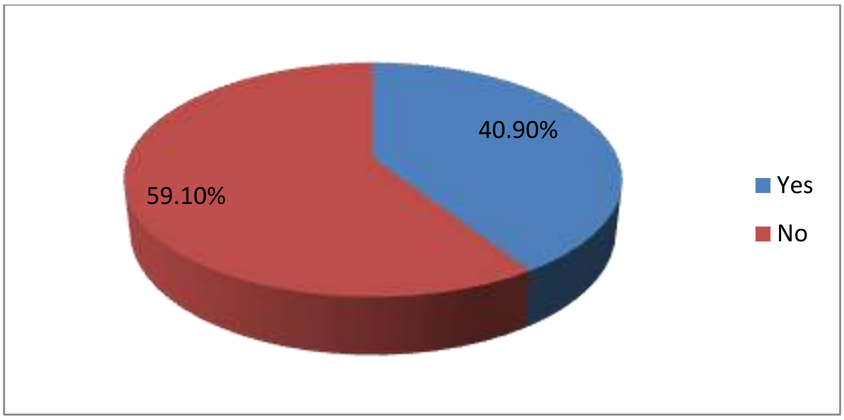

Fig.2: Pie chart showing if Lead City University undergraduate swimming trainees take to land strength training

The chart above shows that 9 (40.9%) do take to land strength training while 13 (59.1%) do not, showing that majority of the participants do not take to land strength training.

Hypotheses testing

Hypothesis 1: There will be no significant main effect of treatment on swimming performance of swimmers in Lead City University, Ibadan.

TABLE 3a: ANCOVA showing main effect of treatment on swimming performance

Source	Type II Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	32.899[a]	11	2.991	20.217	.000	.822
Intercept	240.000	1	240.000	1622.304	.000	.971
Treatment	32.899	1	32.899	20.217	.000	.822
Error	7.101	20	.355			
Total	280.000	22				
Corrected Total	40.000	21				

a. R Squared = .822 (Adjusted R Squared = .782)

The table above shows that the main effect of treatment was significant on swimming performance of swimmers in Lead City University, Ibadan, Nigeria ($F_{(1, 20)}$ =20.217; $p<0.05$; η^2=.822). Therefore the null hypothesis is rejected. The partial eta squared of 0.822 implies that treatment accounted for 82.2% of the observed variance on swimming performance of swimmers in Lead City University, Ibadan.

Table 3b: Adjusted Marginal Mean showing the direction of difference in swimming performance among the groups

Dependent variable	Groups	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Swimming performance	Control	13.972	1.596	12.831	14.114
	Experimental	10.649	.699	10.273	13.024

Table 3b showed that participants in experimental group obtained a lower mean score ($\bar{x}$ =10.649) than the participants in control group who had a mean score of ($\bar{x}$ =13.972), indicating that the participant in the experimental group had lower record time than the participants in the control group. This shows that participants in experimental group performed better than the participant in the control group. It then means that the treatment had effect on swimming performance among the participants.

Hypothesis 2: There will be no significant main effect of gender on swimming performance of swimmers in Lead City University, Ibadan.

Table 4a: ANCOVA showing main effect of gender on swimming performance

Source	Type II Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	14.638[a]	3	4.879	10.773	.000	.366
Intercept	240.000	1	240.000	529.921	.000	.904
Gender	14.638	1	14.638	10.773	.000	.366
Error	25.362	20	1.268			
Total	280.000	22				
Corrected Total	40.000	21				

a. R Squared = .366 (Adjusted R Squared = .332)

The table above shows that the main effect of gender was significant on swimming performance of swimmers in Lead City University, Ibadan, Nigeria ($F_{(1, 20)}$ =10.773; $p<0.05$; η^2=.366). Therefore the null hypothesis is rejected. The partial eta squared of 0.366 implies that gender accounted for about 37% of the observed variance on swimming performance of swimmers in Lead City University, Ibadan.

Table 4b: Adjusted Marginal Mean showing the direction of difference in swimming performance by gender

Dependent variable	Gender	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Swimming performance	Male	10.198	1.026	10.178	11.218
	Female	14.794	.620	13.574	15.014

Table 4b showed that male participants obtained a lower mean score ($\bar{x}$ =10.198) than the female participants who had a mean score of ($\bar{x}$ =14.794), indicating that the male participants had lower record time of finishing than the female participants. This shows that male participants performed better than the female participants.

Hypothesis 3: There will be no significant main effect of body weight on swimming performance of swimmers in Lead City University, Ibadan.

TABLE 5a: ANCOVA showing main effect of body weight on swimming performance

Source	Type II Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	18.261[a]	1	18.261	4.720	.061	.057
Intercept	240.000	1	240.000	4.320	.055	.017
Body weight	18.261	2	9.131	4.720	.054	.016
Error	21.739	19	1.144			
Total	280.000	22				
Corrected Total	40.000	21				

a. R Squared = .057 (Adjusted R Squared = .047)

The table above shows that the main effect of body weight was not significant on swimming performance of swimmers in Lead City University, Ibadan, Nigeria ($F_{(2, 19)}$ =4.720; p>0.05; η^2=.016). Therefore the null hypothesis is accepted. The partial eta squared of 0.016 implies that body weight accounted for about 2% of the observed variance on swimming performance of swimmers in Lead City University, Ibadan.

Table 5b: Adjusted Marginal Mean showing the direction of difference in swimming performance by body weight

Dependent variable	Body weight	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Swimming performance	Under weight	10.650	.474	10.718	12.581
	Normal weight	10.166	.571	10.044	12.289
	Over weight	11.179	6.494	10.808	13.050

Table 4b showed that participants who had normal weight obtained the lowest mean score ($\bar{x}$ =10.166), followed by participants who were underweight with a mean score ($\bar{x}$ =10.650), while participants who were overweight had the highest mean score of ($\bar{x}$ =11.179), indicating that participants with normal weight had lowest record time of finishing. This shows that participants with normal body weight performed better than the other two groups of participants.

Hypothesis 4: There will be no significant interaction effect of treatment and gender on swimming performance of swimmers in Lead City University, Ibadan.

TABLE 6a: ANCOVA showing interaction effect of treatment and gender on swimming performance

Source	Type II Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	38.833[a]	20	1.942	64.907	.000	.671
Intercept	240.000	1	240.000	8022.857	.000	.695
treatment * gender	38.833	1	38.833	64.907	.000	.671
Error	1.167	20	.0583			
Total	280.000	22				
Corrected Total	40.000	21				

a. R Squared = .971 (Adjusted R Squared = .956)

The table above shows that the interaction effect of treatment and gender was significant on swimming performance of swimmers in Lead City University, Ibadan, Nigeria ($F_{(1, 20)}$ =64.907; $p<0.05$; η^2=.671). Therefore the null hypothesis is rejected. The partial eta squared of 0.671 implies that the interaction effect of treatment and gender accounted for 67.1% of the observed variance on swimming performance of swimmers in Lead City University, Ibadan.

Table 6b: Adjusted Marginal Mean showing the direction of difference in swimming performance by interaction effect of treatment and gender among the groups

Dependent variable	Groups	Gender	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Swimming performance	Control	Male	11.536	2.675	10.271	12.801
		Female	13.409	1.742	12.980	13.838
	Experimental	Male	10.037	1.320	10.001	10.936
		Female	12.560	.459	11.657	13.463

Table 6b shows that male participants in experimental group obtained a lower mean score ($\bar{x}$ =10.037) than the male participants in control group with a mean score of ($\bar{x}$ =11.536). This shows that male participants in experimental group performed better than the male participant in control. It then means that male participants in experimental group are better in front crawl swimming performance than male in control. Also from the table female participants in experimental group obtained a lower mean score ($\bar{x}$ =12.560) than the female participants in control with a mean score of ($\bar{x}$ =13.409). This shows that female participants in experimental group performed better than the female participants in control.

The overall comparison showed that male participants in experimental group had the lowest mean score, followed by female participants in experimental group. This means that the intervention had a better effect on swimming performance among males in experimental group.

Hypothesis 5: There will be no significant interaction effect of treatment and body weight on swimming performance of swimmers in Lead City University, Ibadan.

Table 7a: ANCOVA showing interaction effect of treatment and body weight on swimming performance

Source	Type II Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	32.899[a]	13	2.531	16.394	.000	.232
Intercept	240.000	1	240.000	1554.708	.000	.271
treatment * body weight	32.899	2	16.449	16.394	.000	.222
Error	7.101	19	.374			
Total	280.000	22				
Corrected Total	40.000	21				

a. R Squared = .222 (Adjusted R Squared = .272)

The table above shows that the interaction effect of treatment and body weight was significant on swimming performance of swimmers in Lead City University, Ibadan, Nigeria ($F_{(1, 19)}$ =16.394; p<0.05; η^2=.222). Therefore the null hypothesis is rejected. The partial eta squared of 0.222 implies that the interaction effect of treatment and body weight accounted for 22.2% of the observed variance on swimming performance of swimmers in Lead City University, Ibadan.

Table 7b: Adjusted Marginal Mean showing the direction of difference in swimming performance by interaction effect of treatment and body weight among the groups

Dependent variable	Groups	Body weight	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Swimming performance	Control	Under weight	11.429	1.840	10.806	13.051
		Normal weight	10.968	1.199	10.607	11.325
		Over weight	12.008	1.357	10.716	13.334
	Experimental	Under weight	10.967	.908	10.180	12.755
		Normal weight	10.623	.316	10.001	12.244
		Over weight	11.041	.427	10.335	12.613

Table 7b shows that participants with normal weight in the experimental group obtained a lower mean score ($\bar{x}$ =10.623) than the participants with normal weight in control group with a mean score of ($\bar{x}$ =10.968). This shows that participants in experimental group with normal weight performed better than participant with normal weight in the control group. It then means that male participants in treatment group are better in swimming performance than male in control. Also from the table participants in experimental group who are underweight obtained a lower mean score ($\bar{x}$ =10.967) than participants who are underweight in control group with a mean score of ($\bar{x}$ =11.429). Participants who were overweight in the experimental group obtained a lower mean score ($\bar{x}$ =11.041) than the participants who were overweight in control group with a mean score of ($\bar{x}$ =12.008).

The overall comparison showed that participants who had normal weight in the experimental group had the lowest mean, followed by participants who were underweight in experimental group. This means that the intervention had a better effect on swimming performance of participants in the experimental group.

Hypothesis 6: There will be no significant interaction effect of gender and body weight on swimming performance of swimmers in Lead City University, Ibadan.

TABLE 8a: ANCOVA showing interaction effect of gender and body weight on swimming performance

Source	Type II Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	26.761[a]	6	4.460	17.855	.060	.169
Intercept	240.000	1	240.000	60.788	.054	.148
gender * body weight	26.761	2	13.3805	7.855	.076	.169
Error	13.239	19	.697			
Total	280.000	22				
Corrected Total	40.000	21				

a. R Squared = .169 (Adjusted R Squared = .132)

The table above shows that the interaction effect of gender and body weight was not significant on swimming performance of swimmers in Lead City University, Ibadan, Nigeria ($F_{(2, 19)}$ =7.855; p>0.05; η^2=.169). Therefore the null hypothesis is accepted. The partial eta squared of 0.169 implies that the interaction effect of gender and body weight accounted for 16.9% of the observed variance on swimming performance of swimmers in Lead City University, Ibadan.

Table 8b: Adjusted Marginal Mean showing the direction of difference in swimming performance by interaction effect of gender and body weight among the groups

Dependent variable	Gender	Body weight	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Swimming performance	Male	Underweight	10.444	1.794	10.213	11.976
		normal weight	10.051	.796	10.091	10.912
		overweight	11.005	.884	10.556	12.112
	Female	Underweight	12.770	1.170	11.466	14.074
		normal weight	12.319	.408	11.015	14.622
		overweight	12.862	783	11.651	13.418

Table 8b shows that male participants who had normal weight had a highest mean score ($\bar{x}$ 10.051) followed by male participants who were underweight ($\bar{x}$ =10.444) while male participants who were overweight had the least mean score of ($\bar{x}$ =11.005). This shows that male participant who had normal weight performed best. In the female group, participants who had normal weight obtained the highest mean score ($\bar{x}$ =12.319) followed by female participants who were underweight ($\bar{x}$ =12.770) while female participants who were overweight had the least mean score of ($\bar{x}$ =12.862). This shows that female participant who had normal weight performed best. The overall comparism shows that male participants with normal weight had the lowest mean, followed by male participants who were underweight.

Hypothesis 7: There will be no significant 3-way interaction effect of treatment, gender and body weight on swimming performance of swimmers in Lead City University, Ibadan.

Table 9a: ANCOVA showing 3-way interaction effect of treatment, gender and body weight on swimming performance

Source	Type II Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	38.833[a]	23	1.688	52.099	.000	.473
Intercept	240.000	1	240.000	7405.714	.000	.495
treatment * gender * body weight	38.833	2	19.417	52.099	.000	.471
Error	1.167	19	.061			
Total	280.000	22				
Corrected Total	40.000	21				

a. R Squared = .571 (Adjusted R Squared = .552)

The table above shows that the 3-way interaction effect of treatment, gender and body weight was significant on swimming performance of swimmers in Lead City University, Ibadan, Nigeria ($F_{(2, 19)}$ =52.099; $p<0.05$; η^2=.471). Therefore the null hypothesis is rejected. The partial eta squared of 0.471 implies that the 3-way interaction effect of treatment, gender and body weight accounted for 47.1% of the observed variance on swimming performance of swimmers in Lead City University, Ibadan.

DISCUSSION OF FINDINGS

The study found out that dry land training was significant on swimming performance. This may be due to the fact that an optimal level of strength and power is necessary for successful performance in swimming as it is dependent on the maximization of the ability to generate propelling forces and minimizing the resistance offered by the liquid environment. Therefore, strength training programs should be a common practice for swimmers. The finding of this study is in line with the view of Gambeta, (2012) who concluded that dry-land training allows to create an efficient swimmer, without injuries, who is capable of adapting to any stress and competition conditions. He stated further that the aim of dry-land exercises is to better train the human body out of the water to be effective in the water environment. The result is also in agreement with the submission of Johnson, Gauvin and Fredericson,(2013) who stated that appropriate Resistance Training (RT) have performance-enhancing and injury-reducing benefits in youth athletes. They stated further that the awareness of such benefits is demonstrated by an increasing number of swimming coaches working with different age groups that incorporate dry-land training, into their swimming program. The finding negate that of Batalha et al., (2013) who stated that although RT is associated with increased strength, power production and the rate of force development but the exact effects of dry-land training interventions on swimming performance, particularly in youth swimmers is unclear.

The finding of this study also negate that of Johnson et al. (1993) who assessed one repetition of maximum bench press of 29 male swimmers, with ages ranging between 14 and 22 years, and 25 yard swimming velocity (ranging from 1.72 to 2.31 m.s-1). These authors suggested that this measure of dry-land strength did not contribute significantly to the prediction of sprint velocity. It must be noticed that the spectrum of ages should be taken into consideration, especially when within this range significant changes in somatotype occur. By means of a more homogenous group, Garrido et al. (2010) presented a moderate but significant correlation between 6 maximum repetitions of bench press and swimming performance (both 25 and 50 m performance times; $\rho \sim -0.58$; $p < 0.01$) with young competitive swimmers.

Also in support of the finding of this study Crowe et al. (1999) evaluated one maximum repetition in bench press, lat pull down and triceps press, for male and female swimmers. Although significant relationships were obtained between the 3 exercises and tethered swimming forces, significant correlations with swimming performance were only verified in lat pull down for the female swimmers group ($r = 0.64$, $p < 0.05$). The result also agreed with Tanaka and Swensen, (1998) who stated that as with competitive running and cycling, dynamic strength seems to be an important determinant of swimming performance.The finding of this study is in line with that of Strass (1988) who in one of the initiate conducted experiments, in adult swimmers ($n = 10$), detected improvements of 20% to 40% on muscle strength after a strength program using free weights. He stated further that these improvements corresponded to a significant 4.4 to 2.1% increase in performance over 25 and 50 m freestyle, respectively. Moreover, the diving, glide and turns, are responsible for most of the overall performance and this may be taken into consideration when assessing swimming performance. Balilionis, Nepocatych, Ellis, Bishop, Neggers and Richardson (2012) pointed that combining swimming and dry-land strength training is more efficient than the swimming program alone to increase 50m and 400m freestyle performance. Although this could not be proven to professional swimmers, there seems to be a tendency to enhance swimming performance in 25m and 50m freestyle due to strength training. Garrido et al., (2010) concluded that strength training using dry-land regimens enhances the ability to produce propulsive forces in-water, especially in short distance events and among male swimmers.

Research implications, Justification and Novelty of the Study

This study made effort to investigate the effect of dry land strength training on front- crawl swimming performance among undergraduate trainees. It is usual to find trainees especially at the University undergraduate level to always train in the water to achieve chronic adaptation to improving their speed in front crawl. This is understandable because the coaches train these athletes in a competitive environment. This study therefore quizzed the possibility of training in another environment that was not competitive but simulates the competitive environment (dry land) training to specifically improve the strength of the participants and tested its effect on improving speed in front crawl in swimming using the participants' gender and weight as moderating variables. The results were found under the discussion in this study.

CONCLUSION

Based on the findings of this study, it was concluded that dry-land training was effective on swimming performance. Gender has significant effect while body weight had no significant effect on swimming performance. The interaction effect of the two moderating variables was not significant. The study also concluded that the interaction of treatment, gender and body weight has significant effect on swimming performance among swimmers in Lead City, University, Ibadan, Oyo state, Nigeria.

Recommendations

Based on the findings of this study and the conclusion drawn thereof, the following recommendations were made:

1. Swimming coaches need to be educated on the benefits of dry-land exercises to improve swimming performance.
2. Dry-land exercises should be used to train swimmers so as to reduce swimming injuries and increase performance.
3. When designing dry-land training coaches should put into consideration the gender of the swimmers

Conflict of Interest: this research study has no conflict of interest whatsoever.

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