Effect of a Six-week Dry-land Resistance Training on Swimming Endurance of Swimmers in Lead City International School, Ibadan, Nigeria

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Swimming performance is a diverse activity combining energy, kinetic, motor control, anthropometrics, and swimming strength. The use of dry land training for swimmers has received little to no attention in several Nigerian researches. Therefore, this study interest was to examine the effects of a 6-week dry-land resistance training on swimming endurance of swimmers in Lead City International School Ibadan. Pretest-posttest control group experimental research design using matched participants with a 2x2 factorial matrix was adopted for this study. Fifty-two swimmers were selected to take part in the study. The participants were assigned into control group (26) and experimental group (26). Experimental group were made to go through six weeks dry-land resistance training Programme, while the control group were made to undergo 20 minutes of benefits of exercise lesson for six weeks. Data was analyzed using both descriptive and inferential statistics of Analysis of Co-variance (ANCOVA). The result revealed that there was a significant main effect of treatment on swimming endurance($F_{(1,49)}$=102.087, p<0.05, η^2=0.676) of swimmers. Also, there was no significant main effect of sex on swimming endurance($F_{(1,49)}$=0.718, p>0.05, η^2=0.401). Furthermore, there was no significant interaction effect of treatment by sex on swimming Endurance($F_{(1,47)}$=5.524, p<0.05, η^2=0.023). It was concluded that resistance training on dry-land improved swimmers' swimming abilities. Therefore, it was suggested that coaches be taught on the advantages of adopting dry-land training to enhance swimming performance. Also, dry-land resistance training should be used by swimming instructor so as to reduce swimming injuries.

Keywords: Swimming Endurance, Dry-land training, Resistance training, swimming events
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Introduction

Swimming is an individual or team sport that involves moving through water using one's body. The sport may be done in a pool or in open water such as sea or lake. Swimming is characterized by the repetition of a certain bodily action or swimming stroke in order to push the body ahead (Burcu ErtasDolek& Elif Cengizel, 2019). There are several strokes, each of which defines a distinct swimming style or crawl. Front crawl, breaststroke, backstroke and butterfly are examples of swimming strokes. All main body components, including the torso, arms, legs, hands, feet and head, move in a rhythmic and synchronized manner throughout most strokes (Burcu ErtasDolek& Elif Cengizel, 2019).

Endurance is one of the most important elements to be considered in a number of competitive sport (Gavriil Arsoniadis, et.al. 2022). It is usually used in aerobic and anaerobic exercises because it is an essential prerequisite for swimming performance[3]. Endurance is the ability to perform mechanical work over a longer period of time, thus delaying the depletion of the energy supplies available in the muscle cells (***Blythe. L, 2016***). The body gradually diminishes the effects of the residual substances accumulated as a result of tissue metabolism, through the buffer systems and the mechanisms for the removal of effort-induced catabolites[3]. The improvement of endurance is linked with an increase of the number of mitochondria and the higher oxidative capacity of the muscles (***Blythe. L, 2016***).

Swimming strokes necessitate different set of skills. The type of stroke or swimming event is one of the determinants of swimming performance. Generally, swimming performance can be influenced by the types of style adopted by the swimmer (***Glenn, 2017***). In most cases, the breast-stroke and front crawl swimmers have shown improved level of performances when compared to their counterparts in the other two strokes. It has also been shown that differences exist in the performance of the swimmers across the four strokes in terms of techniques, energy cost and stroke length (***Lampros, Polites, & Coubertin Pierre, 2020***). For different levels of athletes (national level, international level), the changes in the sex gap over time showed that the sex-related differential in swimming speed was bigger for freestyle than for breaststroke at race distances ranging from 50 m to 200 m for national swimmers, but not for international swimmers(***Lampros, Polites & Coubertin Pierre,2020***).

Swimming is a low-impact aerobic activity, which attract the participation of all category of human being. Children as young as six months and adults in their seventy enjoy swimming especially in developed countries. In some developing countries swimming is gaining currency as swimming is included in many primary and post primary school curriculum and age group competitions are organized as observed by the researcher **(**Burcu ErtasDolek& Elif Cengizel, 2019**)**. Since the foundation of the first modern Olympic Games in 1896, the sport of swimming has been a component of the Olympic events. There are 34 swimming events, with distances ranging from 50 to 10,000 meters, making swimming one of the most well-liked Olympic sports. At the 2016 Rio Olympics, winning

times for Olympic gold medals ranged from 21.4 seconds for the 50-meter dash to 1 hour, 56 minutes, and 32.1 seconds for the 10,000-meter competition (Barronswim, 2020).

Swimming is one of the most popular Olympic sports, with 34 events covering distances of 50 to 10,000 meters. Olympic gold medal winning times ranged from 21.4 seconds for the 50-meter dash to 1 hour, 56 minutes, and 32.1 seconds for the 10,000-meter competition at the 2016 Rio Olympics. A median time of under two minutes and 20 seconds is required for 26 of the 34 swimming events at the Olympics, which are held over distances of 200 meters or less. Even though the majority of swimming competitions are short-lived, swimmers' training regimens frequently involve significant training volumes, such as the total distance or duration completed each session, week, or month, for instance. This form of instruction is used regularly by swimmers of all ages and abilities. Competitive swimmers also train far more regularly than athletes in other cyclical sports like running, rowing, cross-country skiing, and cycling. This is particularly true for young swimmers; whose weekly mean swimming training volumes range from 16 hours on average to 29 hours (or 110 km) on rare occasions (***Cojocaru and Cojocaru, pg. 370-76, 2016***).

In order to promote training adaptation, training aims to enhance performance by progressively and methodically increasing training stressors (such as volume, intensity, and frequency of training)(Toketemu& Gans, 2022). A well-liked theory of training adaptation is the general adaptation scheme (GAS), which was first proposed by Hans Selye and is depicted in Figure 2.9 (Cheilleachair& Harrison, 2017). According to the GAS theory, a training stressor occurs in an early alpha phase that generates soreness, stiffness, and fatigue, which lowers performance (P)(Nugent & Comyns, 2016). The resistance phase eventually began as a result of the alarm phase's gradual activation of adaptable mechanisms. During the retention phase, the body may undergo beneficial modifications that either bring it back to its initial homeostasis or restore it to a new, more suitable state (i.e. supercompensation) (Nugent, Comyns, & Warrington,2017). However, if the appropriate training volume or intensity is too high to recover from, or if the amount of training stress is excessive, the exhaustion stage may emerge, which can lead to overtraining (Yuki Funai,et.al, 2020).

Dry-land resistance training is the activity done on land with the intended purpose of increasing strength, flexibility and overall physical mobility. This includes a number of different movements and exercises ranging from beginner to advanced skill level. Some exercises that are commonly performed include pushups, sit-ups, squats, etc (***Jones. J, 2017***). In well-trained endurance athletes, dry-land resistance training can result in an improved capacity for both long- and short-term endurance (Mu-Yeop JI, et.al,2021). Swimmers training need to include a wide range of resistance training because they require a good level of endurance whether they swim long distance or short. Power training as a type of dry-land resistance training has the potential to develop muscle strength under dynamic conditions. The demand of dry-land resistance training in addition to the aerobic and anaerobic in-water training have the potential of optimizing physical requirements of swimming which in turn influence the performance (Mike Heath, 2019). An increase in dry-land resistance training should translate to a stronger and more effective swimming skill performance (Fone, Tillaar & Fone,2022).

Statement of the Problem

From the researcher's observations, Lead City International School Swimmers focused on the use of repetitive swimming in the pool as their training method. The only land based activities engaged in during training sessions are light stretching before entering the pool which are not regular practices. The researcher is of the opinion that if the swimmers' endurance could be improved, the chance that they will do better during competition is more likely. Previous studies focused more on strength training as a way of improving swimming performance. Findings revealed that combining swimming and dry-land strength training improves performance in different events more effectively than the swimming programme alone (L. Fone, R. Tillaar & L. Fone, 2022). On the other hand, previous studies paid minimal or no attention to the use of dry land training for athletes in swimming. As a way of providing objective evidence as to the efficacy of dry-land training in enhancing performance in swimming, this study interest is to examine the effects of a 6-week dry-land resistance training on swimming endurance swimmers in Lead City International School Ibadan, Oyo State, Nigeria.

Research Question

1. What is the resting heart rate of swimmers before and after six weeks Dry-land resistance training in Lead City International School, Ibadan?

Hypotheses

The following hypotheses were tested in this study:

1. There will be no significant main effect of treatment on swimming endurance of swimmers in Lead City International School, Ibadan following a 6-week Dry-land resistance training.
2. There will be no significant main effect of sex on swimming endurance of swimmers in Lead City International School, Ibadan following a 6-week Dry-land resistance training.
3. There will be no interaction effect of treatment and sex on swimming endurance of the swimmers following a 6-week Dry-land resistance training.

Methodology

Informed consent forms was handed out through each volunteer for parents to confirm of their wards willingness to participate in the study. The randomized pretest-posttest control group experimental research design using matched participants with a 2x2 factorial matrix was adopted for this study. The design employed two groups of participants which were designated, experimental and control groups.The population for this study included all male and female student swimmers of Lead City International School, Ibadan. The sample size for this study was Fifty-two (52) volunteer swimmers of Lead City International School. The participants were chosen using a multistage sampling technique. The following are the phases involved in the procedure.

Stage 1: Purposive sampling technique was used to select fifty-two (52) swimmers in Lead City International School.

Stage 2: Fifty-two (52) volunteers were pretested on the dependent variables.

Stage 3: Participant were matched by swimming performance and sex and randomly assigned to each group of experimental (26) and control (26).

In order to ascertain the effect of 6-week dry-land resistance training on swimming endurance of swimmers in Lead City International School, Ibadan, Nigeria, standardized instruments were used to measure the swimming endurance and speed of the respondents.

Treatment Group: There was pre-test measures of the selected dependent variable (swimming endurance) of the participants before random assignment to the one group. Number of laps was used to measure the swimming endurance of the participants. Experimental group were made to go through a six (6) weeks dry-land resistance training programme three (3) days a week. After the programme, they were tested again as the post-test measures.

Control Group: There was pre-test of the selected dependent variable (swim endurance) on the control group. They were made to undergo 20 minutes of benefits of exercise lesson) for six weeks at non-consecutive days per week. This process led to the post-test measures which was take place after the 6 weeks of training.

Informed consent forms was handed out through each volunteer for parents to confirm of their wards willingness to participate in the study. Also participants were made to realize that they may experience some discomfort like muscle cramps and pains at the beginning of the training. However, they were admonished not to pull out by assuring them that the pains are only some of the early effects of the training which will reduced as their bodies adapt through regular participation in the training programme. See appendix for the Informed Consent Form.

All the instruments that were used by the researcher for testing have been utilized by other researchers to test the various physical fitness components and have been found to be reliable.Reliability is the consistency with which an instrument measures what it purports to measure. The instruments for this study were standardized instrument, but for the purpose of this study the instruments were recalibrated where necessary.Descriptive statistics of frequency count and percentages was used to analyze the demographic data of the participants while mean and standard deviation was used to determine the anthropometric compositions of the participants. Inferential statistics of Analysis of Co-variance (ANCOVA) was used to test the hypotheses formulated at 0.05 level of significance.

Results

The results and discussion of findings are presented based on demographic characteristics of the participants, research question and hypotheses as follow:

Demographic Data Analysis

Table 1: Distribution of the Participants by Sex

Sex	Frequency	Percent
Male	26	50.0
Female	26	50.0
Total	52	100.0

Source: Field Survey, 2022.

Table 1 reveals that equal number of male and female respondents sampled in this study.

Research Question

The research question below was answered:

Research Question: What is the resting heart rate of swimmers before and after six weeks in Lead City International School, Ibadan?

Table 2: Distribution of the Participants by Heart Rate (Beat/Minute)

Mean and Std. Deviation	**Heart Rate Pre-test score**	**Heart Rate Post-test score**
Mean	64.1731	63.3654
Std. Deviation	2.65479	2.80076

Source: Field Survey, 2022.

The result shows that the mean heart rate of the participants for the pretest stage was 64.1731, while that for posttest was 63.3654 was recorded at posttest stage. This result indicates that, pre-testheart rate was higher by 0.81 compare to that of the posttest score. This means that, there was a decrease in the heart rate of swimmers in Lead City International School swimmers.

Hypotheses

The following hypotheses were tested in this study.

Ho1: There will be no significant main effect of treatment on swimming endurance of swimmers in Lead City International School, Ibadan.

Table 3: Summary of Analysis of Covariance of Main Effect of Treatment on Swimming Endurance (Number of laps/time) of participants

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	31526.309[a]	2	15763.155	12716.380	.000	.998
Intercept	.886	1	.886	.715	.402	.014
Pretest	23590.198	1	23590.198	19030.577	.000	.997
Treatment	126.547	1	126.547	102.087	.000	.676
Error	60.740	49	1.240			
Total	690342.200	52				
Corrected Total	31587.049	51				

Table 3 shows that there was a significant main effect of treatment on swimming endurance($F_{(1,49)}$=102.087, p<0.05, η^2=0.676) of swimmers in Lead City International School, Ibadan. The null hypothesis was therefore rejected. This implies that treatment (dry-land resistance) was effective in improving the swimming endurance of swimmers in Lead City International School.

Table 4: Estimated Marginal Means of Treatments on Swimming Endurance (Number of laps/time) of participants

Treatment	Mean (Number of laps/time)	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Experimental (Dry-Land Training)	110.811	0.232	110.346	111.276
Control (Talk on Benefits of Exercise)	114.297	0.232	113.831	114.762

The Table 4reveals that after controlling for initial difference on swimming endurance, the participants exposed to dry-land resistance training had a lower mean score (mean=110.811), while the control had a higher mean score of 114.297. This implies that dry-land resistance training with the least mean score was more effective in relation to swimming endurance of swimmers in Lead City International School.

Ho2: There will be no significant main effect of sex on swimming endurance of swimmers in Lead City International School.

Table 5: Summary of Analysis of Covariance of Main Effect of Sex on Swimming Endurance (Number of laps/time)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	31402.468	2	15701.234	4168.135	0.000	0.994
Intercept	21.899	1	21.899	5.813	0.020	0.106
Pretest	30102.468	1	30102.468	7991.164	0.000	0.994
Gender	2.706	1	2.706	0.718	0.401	0.014
Error	184.581	49	3.767			
Total	690342.200	52				
Corrected Total	31587.049	51				

Table 5 shows that there was no significant main effect of sex on swimming endurance($F_{(1,49)}$=0.718, p>0.05, η^2=0.401) of swimmers in Lead City International School, Ibadan. The null hypothesis was therefore considered tenable. This implies that sex had no impact on swimming endurance of swimmers in Lead City International School.

Table 6: Estimated Margin al Means of Sex on Swimming Endurance (Number of laps/time) of participants)

Gender	Mean (Number of laps)	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Male	112.787	0.385	112.013	113.561
Female	112.320	0.385	111.546	113.094

Table 6 reveals that after controlling for initial difference of sex on swimming endurance, female had a lower mean score of (112.320) than their male (112.787) counterpart, but the difference (0.467) was not substantial.

Ho3: There will be no significant interaction effect of treatment and sex on swimming endurance of swimmers in Lead City International School

Table 7: ANCOVA Analysis of Interaction Effect of Treatments by Sex on Swimming Endurance of participants (Number of laps/time)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	31532.862	4	7883.215	6837.580	.000	.998
Intercept	.323	1	.323	.281	.599	.006
Pretest	22150.523	1	22150.523	19212.461	.000	.998
Treatment	121.272	1	121.272	105.187	.000	.691
Gender	.237	1	.237	.206	.652	.004
Treatment & Gender	6.369	1	6.369	5.524	.023	.105
Error	54.187	47	1.153			
Total	690342.200	52				
Corrected Total	31587.049	51				

Table 7 shows that there was no significant interaction effect of treatment bysex on swimming Endurance($F_{(1,47)}$=5.524, p<0.05, η^2=0.023) of swimmers in Lead City International School, Ibadan. The null hypothesis was therefore considered tenable. This implies that sex had no observable impact on swimming endurance of swimmers in Lead City International School.

Table 8: Estimated Marginal Means of Treatment and Sex on Swimming Endurance (Number of laps/time)

Treatment	Gender	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Experimental (dry-land training)	Male	110.554	.314	109.923	111.185
	Female	111.118	.303	110.509	111.727
Control (talk on benefits of exercise)	Male	114.693	.299	114.092	115.294
	Female	113.851	.324	113.199	114.503

Table 8 shows that male participants in the experimental group had a lower mean score (110.554) compared to their female (111.118) counterparts. The difference between males and females in experimental group in the estimated marginal means for swimming endurance is 0.564 with males having a lower value. In the control group, the male participants had a higher marginal mean score (114.693) than their female (113.851) counterpart. The difference between their marginal mean scores in swimming endurance is 0. 842. This value is much higher than those for the experimental group. The overall comparison shows that male participants in experimental group had the lowest mean score.

Discussion of Findings

The result in this study revealed that there was a significant main effect of treatment on swimming endurance. This means that Dry-land Resistance training had effect on swimming endurance of swimmers in Lead City International School. This finding is in agreement with a previous study which determined the effect of Dry-land core training on physical fitness and swimming performance in adolescent elite swimmers(JI Mu-Yeop, Jin-Ho YOON, Ki-Jae SONG, & Jae-Keun OH,2021).The result revealed that,anaerobic power, core stability, upper extremity muscular endurance, and swimming performance witnessed significant improvements as a result of the 12-week dry-land core training programme.In addition**,** after controlling for initial difference on swimming endurance, the participants exposed to dry-land resistance training had a lower mean score**,** while the control had a higher mean score. This implies that dry-land resistance training with the least mean score was more effective in relation to swimming endurance of Lead City International School Swimmers.

In regard to whether sex was a factor in training on swimming endurance, the result of this study revealed that there was no significant main effect of sex on swimming endurance of swimmers in Lead City International School, Ibadan. This implies that sex had no impact on swimming endurance. This result is in line with a study conducted on sex differences in youth elite swimming. The result revealed that there were no sex-related differences in swimming performance (Senefeld, 2019). In another study on sex differences in elite swimming with advanced age, the result revealed that there was no gender difference in peak performance in ultra-endurance swimming performance (Senefeld, Joyner,Stevens & Hunter, 2019).

Another finding of this study was that there was no significant interaction effect of treatment by sex on swimming Endurance of swimmers in Lead City International School, Ibadan. Male participants in the experimental group had a lower mean score compared to their female counterparts. The difference between males and females in experimental group in the estimated marginal means for swimming endurance was lower for males. In the control group, male participants had a higher marginal mean score than their female counterpart. The overall comparison shows that male participants in experimental group had the lowest mean score. It implied that the interaction of treatment and sex had a better effect on male participants' swimming endurance who were exposed to

dry-land resistance training than their female counterparts and the control group though the differences were not significant.

Conclusion

Based on the findings of this study, it was concluded that dry-land resistance training was effective in enhancing swimming endurance of the participants. It was further concluded that sex was not a determinant of training outcome of swimming endurance of swimmers in Lead City International School, Ibadan.

Recommendations

The following recommendations were made:

i. Swimming instructor should be educated on the benefits of dry-land resistance training in order to improve swimming performance and that dry-land resistance training should be introduced to the swimmers as a means of improving swimming performance.
ii. Dry-land resistance training should be used by swimming instructor so as to reduce swimming injuries.

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