JOURNAL OF HEALTH, PHYSICAL EDUCATION, SPORTS AND LEISURE STUDIES
ISSN: 0795-5316 (Print) | Vol. 11, No. 1, July 2026 | pp. 79–88
Published by the Department of Human Kinetics and Health Education, Faculty of Education, Ahmadu Bello University, Zaria, Nigeria

EFFECT OF RESISTANCE TRAINING ON AEROBIC CAPACITY (VO2MAX) OF MALE TAEKWONDO ATHLETES OF THE NIGERIAN ARMY

[1]Akpah Adakole John, S.U. Omeiza, [2]J.A. Gwani, [3] E.A. Gunen, [4]S.Y.Musa, [5]AR. Bello, [6]S.H. Hussaini

Department of Human Kinetics and Health Education, Ahmadu Bello University Zaria
Corresponding Author's Email: budokatana@gmail.com

Abstract

The purpose of this study was to assess the effect of resistance training on aerobic capacity (VO_2max) of male taekwondo athletes of the Nigerian Army. To achieve the purpose of the study a research question and null hypothesis were formulated. They were aimed to assess the effect of resistance training on the aerobic capacity (VO_2max) of male taekwondo athletes of the Nigerian Army. A repeated measures experimental research design was used for the study. A multistage sampling technique of purposive, stratified and simple random sampling was used to select 20 male taekwondo athletes, between the ages of 18 to 24 and have competed in the national championship as sample size for the study. The training intensity was maintained between 70% to 90% of one repetition maximum (1RM). The training programme had three sessions of moderate to high intensity resistance training per week for a duration of 12 weeks. includes Resistance machine, Holtain Stadiometer, whistle (fox-40) model, electronic stop watch and 3.2 km course were used as instruments for the study. participants trained at 70% of 1RM from baseline to 4th week, at 60% of 1RM from 4th week to 8th week and at 90% of 1RM from 8th week to 12th week. The selected biomotor abilities variables were assessed at baseline, at the end of 4th, 8th, and 12th weeks of training period. The variables measured was aerobic capacity (VO_2max). Descriptive statistics of mean, standard deviation and standard error were used to answer the research question, while repeated measures analysis of variance were used to test the null hypothesis formulated at 0.05 level of significant. Findings of the study revealed significant effect of resistance training on aerobic capacity (VO_2max) ($p = 0.000$) of male taekwondo athletes of the Nigerian Army; therefore, the null hypothesis was rejected. Bonferroni Post hoc Test further revealed that the significant effect of the resistance training on the selected variables manifested at the end of 4th, 8th, and 12th weeks of training. On the basis of these findings it was concluded that resistance training significantly improved the aerobic capacity (VO_2max) of male taekwondo athletes of the Nigerian Army. On the basis of these conclusions, it was recommended that the Nigerian Army taekwondo coaches and athletes should ensure that resistance training between 70-90% of 1 RM and periodic biomotor abilities evaluation should be integrated into their comprehensive fitness training regimen in order to enhance Nigerian Army male taekwondo athletes' aerobic capacity (VO_2max) for performance proficiency in training and competitions.

Keywords: *Biomotor Ability, Aerobic Capacity, Taekwondo*

How to cite this article: John, A. A., Omeiza, S. U., Gwani, J. A., Gunen, E. A., Musa, S. Y., Bello, A. R., & Hussaini, S. H. (2026). Effect of Resistance Training on Aerobic Capacity (VO2max) of Male Taekwondo Athletes of the Nigerian Army. Journal of Health, Physical Education, Sports and Leisure Studies, 11(1), 79–88.

DOI:

INTRODUCTION

Taekwondo is a Korean martial art which has been in existence for over 2000 years. Literally, it means the path or ways of fist and foot. It is a multidimensional science and art of kicking and punching with emphasis on discipline (Zhao, Hohmann, Chang, Zhang, Pion, & Gao, 2019). The distinctive characteristics and attributes of this noble martial art of taekwondo, coupled with its emphasis on complex and dynamic kicking and striking techniques, differentiate it from other martial arts and combat event (Tornello, Capranica, Minganti, Chiodo, Condello, & Tessitore, 2014). Taekwondo has transcended scientifically into a unique and universally recognised combat sport. Thus, making it one

of the most widely practised martial art globally, with over 70 million participants in 180 nations of the world (Zhao *et al.*, 2019). This noble martial art of taekwondo was formally recognised as a scoring Olympic combat sport during the Sidney 2000 Olympic Games (Ryan Chong, 2018).

Technical and tactical skills in competitive taekwondo integrate wide range of attack, counterattack, and defensive system of foot and fist techniques, coupled with foot work manoeuvring. These techniques are usually performed intermittently with high intensity, requiring an ideal aerobic capacity (VO_{2max}) (Bridge, Ferreira da Silva Santos, Chaabene, Pieter, & Franchini, 2014). Therefore, it is essential to develop and enhance these performance indicators in Taekwondo athletes for performance proficiency (Ferreira da Silva Santos, Herrera-Valenzuela, & Franchini, 2019).

Aerobic capacity (VO_{2max}) is one of the essential biomotor abilities to be developed by taekwondo athletes for performance optimization in taekwondo training and competitions. Aerobic capacity also known as cardiovascular fitness, cardiorespiratory endurance or VO_{2max} as described by Tomkinson, Lang, Blanchard, Léger, and Tremblay (2019) as the ability to perform dynamic exercises involving large muscle groups at moderate to high intensity level for prolong periods of time. It is also described as the ability of athletes to perform series of submaximal physical exertion efficiently at a predetermined intensity over a prolong period of time without the setting in of undue fatigue (Wolff, Bieleke, & Schüler, 2019). Aerobic capacity reflects the capacity of the heart, lungs and blood to efficiently transport oxygen to the working muscles, which is utilized during physical exercise, and is a good indicator of aerobic fitness (Raj, D'Cruz, Toms, Muralidharan, & Rao, 2018). Therefore, considering the high intensity and intermittent nature of taekwondo training and competition, the athletes are required to develop an efficient endurance capacities to cope with the demand of the event (Barley, Chapman, Guppy, & Abbiss, 2019; Rahmani-Nia, 2020).

Aerobic capacity is the most essential component of biomotor ability that should be developed first before the development of other performance indices (Rahman & Siswantoyo, 2018). Without an ideal aerobic capacity, it is practically difficult for athletes to perform repeated movements of other types during a training programme, which is required in facilitating the development of other biomotor components of fitness (Cipryan, Tschakert, & Hofmann, 2017; Fort-Vanmeerhaeghe, Romero-Rodriguez, Lloyd, Kushner, & Myer, 2016; Rahman & Siswantoyo, 2018). Research findings have shown that resistant training is one of the conditioning programmes that can be explored by combat sports coaches and trainers in developing the aerobic capacity efficiency and other indices of performance in athletes (Granacher, Lesinski, Büsch, Muehlbauer, Prieske, Puta, Gollhofer, & Behm, 2016).

STATEMENT OF THE PROBLEM

The Nigerian Army sports' policies and objectives are to ensure performance proficiency of Nigerian Army Taekwondo athletes in national championships, through the utilization of ideal and effective training method. Despite this policies and objectives, the performance profile of the Nigerian Army male Taekwondo athletes in national championship in recent times is fast declining, as reflected on their position and ranking on the national medal table from 2018 – 2023 (Nigerian Taekwondo Federation, 2023). This poses a subject of concern to the Nigerian Army Taekwondo coaches, trainers and athletes. Efforts to enhance their performance are often centred on an orthodox method of training at the detriment of other ideal method of training, such as resistance and plyometric training that may enhance the required performance indicators of biomotor abilities of the athletes.

Suffice to mention that the researcher observed that the performance declination of the Nigerian Army male Taekwondo athletes in national championship may to a large extent be due to the team's low level of biomotor abilities development. These is evident in their inability to score valid points on their opponent's electronic protector above the required scoring threshold as a result of lack of lack of explosive power ability to execute explosive techniques with maximum impact and low level of aerobic capacity to sustain the tempo of a match. The researcher further observed that this negative performance of the team may be due to the conservative and orthodox methods of training applied by the Nigerian Army coaches and trainers in training their athletes as against paradigm shift in training method. This trend, if not check may lead to continuous performance decline which would in turn adversely affect the team's chances of winning national medals. Thus, truncating the team's opportunity of being selected

into the national team to represent the Nation in continental and international tournaments such as All African games, Olympic Games, World Military games and World Taekwondo Championships.

PURPOSE OF THE STUDY

The main purpose of this study was to assess the effect of resistance training on aerobic capacity (VO_{2max}) male Taekwondo athletes of the Nigerian Army.

RESEARCH QUESTION

In line with the research focus, the study was conducted to answer the following research question:

1. Would RT enhance the aerobic capacity of male Taekwondo athletes of the Nigerian Army?

HYPOTHESIS

In line with the purpose of the study and the research question, the following hypothesis was formulated to guide the conduct of this research.

1. There is no significant effect of RT on the aerobic capacity (VO_2 max) of male Taekwondo athletes of the Nigerian Army.

METHODS AND MATERIALS

Repeated-measures experimental research design was adopted for the purpose of this study. In this design, the same participants were assessed repeatedly on the independent variable (Cohen, Manion, & Morrison, 2007). Data was obtained using RT among Nigerian Army male Taekwondo athletes at the baseline, at the 4^{th}, 8^{th} and 12^{th} week of training. The selected biomotor abilities variables was assessed in the Army School of Physical Training (ASPT) Gymnasium, Chindit Cantonment, Zaria.

Twenty (20) male taekwondo athletes of the Nigerian Army were drawn from the total population (33) of all the male taekwondo athletes of the Nigerian Army; and served as participants for the study. A multistage sampling technique of purposive, stratified and simple random sampling were used to select the participants. The instruments used for data collection included: Resistance machine, holtain stadiometer, whistle (fox-40) model, electronic stop watch and 3.2 km course. The procedures for data collection were based on the guidelines and recommendations of ACSM (2020) for all the variables. The statistical techniques used in analysing the collected data for this study were the descriptive statistics (means and standard deviation) and inferential statistics of repeated-measures analysis of variance (ANOVA) and Bonferroni's post hoc test. An alpha-level of 0.05 was used to accept and reject the null hypotheses.

Training Protocol

Resistance training (RT) is an ideal and effective structured method of training, which utilizes weights as resistance to generate muscular contraction force necessary in the development of biomotor abilities variables (Nunes, Grgic, Cunha, Ribeiro, Schoenfeld, de Salles, & Cyrino, 2021).

The résistance programme designed for this study was made up of selected resistance drills utilizing American Multi Fitness Ergo Gym Machine (2020 Model AF) Resistance machine. The resistance exercises designed for this study placed emphasis on the upper extremities of the body, lower extremities of the body and the trunk region of the body. The training protocols was designed in such a way that the upper extremities of the body are alternating with the lower extremities of the body during the exercise. That is while the arms and shoulder are engage in exercise, the legs are recovering from previous exercise. The American Multi Fitness Ergo Gym Machine (2020 Model AF) Resistance machine has variable resistance weight, which was easily set and reset by manipulating the resistance machine selector pin to set the desired resistance weight needed.

Prior to the commencement of the RT programme, participants were required to perform a warm-up exercises for 10 minutes. The warm-up exercise was comprised of the following;

a. General warm-up: The general warm-up was designed to tune the body physiological parameters above resting level by indicating the tissues, organs, and systems of the participant's body

to get set for physical exertion. The participants were required to undergo general warm-up for 5 minutes, consisting of light jogging, cycling on bicycle ergometre, squat thrust and jumping jacks.

b. Specific warm-up: The specific warm-up was designed to sensitize and tune up participants' physiological variables required for specific taekwondo training, these includes static and dynamic stretching exercises. The participants were required to perform these stretching exercises for 5 minutes. These exercises included; arms, shoulders, biceps, trunk, hamstring muscles, calf muscles, upper and lower legs. this was to avoid discomfort and injury during the main RT programme.

c. Cool down exercises: The cool down exercises was designed to return the body physiological parameters to resting state after vigorous activities of the resistance training programme. The cool down exercises was for 5 minutes, which will comprise brisk walking to prevent blood pulling in the legs, light stretching and breathing exercise (in and out). The aforementioned protocols were observed strictly prior to the commencement of each training phase and after each training session, throughout the duration of the resistance training programme.

The RT programme was designed and structured to last for a duration of 12 weeks, with the training session structured into three phases. Each phase was designed to last for the period of four weeks. Thus, the phases of the resistance training programme were organised sequentially in the following order; first phase was week 1 to week 4, second phase was week 5 to week 8, and the third phase was week 9 to week 12 respectively in that sequence.

The resistance training session was structured to elapse for one hour (60 minutes) and the training session was on alternate days excluding Saturdays and Sundays to avoid fatigue and enable recovery of the participants. Thus, the training session was Monday, Wednesday, and Friday per week for twelve weeks (3 months).

The training took place in the morning between the hours of 7.30 and 8.30 a.m. in the following phases:

1. First Phase: This was the initial training session which was scheduled to last for 4 weeks. The RT intensity was 70% 1-RM of 15 repetitions of 3 sets with an interval of rest between each set $1^{1/2}$ minutes.
2. Second Phase: The second phase which also lasted for 4 weeks. In this phase, the resistance training intensity was 80% 1- RM of 15 repetitions of 3 sets with a rest interval of 2 -3 minutes between each set.
3. Third Phase: This was the last phase of the training session, which also lasted for 4 weeks. The resistance training intensity increased to 90% of 1-RM of 15 repetitions of 3 sets with 2-3 minutes' interval of rest between each set.

The main objective of the 12 weeks' resistance training programme was for the development of aerobic capacity of male Taekwondo Athletes of the Nigerian Army. Thus, after the completion of each phase of training, biomotor ability test and evaluation of the participant's aerobic capacity was conducted using 3.2 km test for aerobic capacity and the result obtained was recorded.

The resistance training was performed on 6 different exercise stations of resistance machines: hand dip, lateral pull, leg press, leg curls, abdominal curl and leg extensions, which are to be completed within 60 minutes. Using resistance machines was safer and easy because machines have variable resistance, which require less time to set by quickly using s selector pin to change resistance.

Static stretching exercises for the muscle groups such as triceps stretch, quadriceps stretch, side stretch, body rotation, knee-to-chest stretch, and back extension stretch were performed during rest intervals of 2 minutes between exercise stations, before and after each session. Each training session began with a 10-min warm-up and ended with another 5-min cool-down using bike ergometer and very light resistance by completing a set of 5-10 repetitions of the exercises at a very low intensity of between 10% and 20% of IRM.

Six (6) resistance exercise stations were performed engaging muscle groups, with a focus on strengthening the upper-and lower-body muscles that are relevant for developing and enhancing the biomotor abilities of Taekwondo athletes, which include hand dip, lateral pull, leg press, leg curls, abdominal curl and leg extensions. The training was structured according to recommendations of the American College of Sports Medicine and consisting of six stations resistance exercises for each major

muscle groups of the upper and lower limbs, such as the chest, back, biceps, triceps, lower back, gluteus, quadriceps and hamstrings. Each exercise was performed by active participation (without assistance) of three sets with a minimal interval of 60 seconds between sets and at least 120 seconds between exercise stations. The RT programme was structured based on current recommendations on the practice of RT for athletes (Garber *et al*., 2011, ACSM, 2020). The intensity for the training was determined by selecting a load equating to 70%, 80% and 90% of 1RM progressively after every four weeks. The intensity was determined by calculating the percentage of one repetition maximum (% 1RM) as follows: the moderate-high intensity of 3 sets, 15 reps at 70% of 1RM max for the first 4 weeks, 3 sets of 15 repetitions at 80% of 1RM in the second 4 weeks and 3 sets of 15 reps at 90% of 1RM for the last 4 weeks of the training (ACSM, 2020; Diogo, Henrique, and Mario, 2020).

As training progresses, resistance or load were gradually increased after every four weeks of training. These increments was within the range recommended by the ACSM in their relevant position stand on progression models in RT that have been used without adverse effects in similar studies with athletes (Davies, Tran, Hogan, Haff, & Latella, 2021). The incremental load increase was first started with number of repetitions (15), then followed by 10% of RM increase after every 4 weeks so that the initial training intensity was preserved throughout the 12-week training. The participants performed a total of 3 sets of 15 repetitions each at every exercise station, with a load corresponding to 90% of 1RM in the first 4 weeks of training. Then, the load was increased to 3 sets of 15 repetitions at 80% of 1RM for another 4 weeks and 90% of 1RM for the last 4 weeks, respectively.

The participants push or pull the same relative loads and complete the same amount of work progressively and was tested at different points (at base-line, at the end of 4^{th}, 8^{th} and 12^{th} week) of resistance training for comparison. The training sessions lasted 60 minutes for 3 alternate days per week (Monday, Wednesday and Friday). The moderate-high intensity RT programme used in this study followed the principles of specificity, individualization, adaptation and progression (Haff & Triplett, 2016; Fragala *et al*., 2019; ACSM, 2020). The resistance training exercise was arranged in an alternating order, working on the upper-body and lower body muscles such that while leg muscles were recovering the arms muscles will be working. The sequence of the exercises was arranged in such a way that no two consecutive exercise involving same muscle groups follow each other i.e. alternating exercise for arms, legs and between flexor and extensor muscle groups. The training also ensured muscular balance; that is, training of large muscle or multi-joints exercises first and synergist or single-joint exercise last. For example, leg press was followed by leg curls or leg extension and abdominal curl followed by biceps curls or hand dips. During the execution of movements, participants were instructed to breathe in during the eccentric phase using execution movement speed of a ratio 1:2 concentric/eccentric phases, respectively.

Data obtained from the study was analysed using descriptive statistics of mean, standard deviation and standard error and inferential statistics using repeated-measures analysis of variance. This was because the same group of participants were measured at four points over time (at base-line, at the end of 4^{th}, 8^{th} and 12^{th}) of training phases respectively. An appropriate test of Bonferroni post hoc was used to further determined where the difference in the training effect was located. All analyses were performed using the statistical package for social sciences (SPSS) version 23. The decision to retain or reject the null hypotheses formulated for the study was be made at an alpha-level of $P < 0.05$ and the results are presented and discuss below

RESULTS.

The results are presented according to the research question and null hypothesis formulated. Descriptive statistics on the physical characteristics of participants age (years), weight (kg), height (m) and body mass index (kg/m^2) is presented in Table 1.

Table 1: Physical Characteristics of Male Taekwondo Athletes of the Nigerian Army

Variable	N	Mean	SD	SEM
Age (years)	20	20.45	1.19	0.26

Variable	N	Mean	SD	SEM
Weight (kg)	20	79.10	8.95	2.00
Height (m)	20	1.84	0.04	0.01
BMI (kg/m^2)	20	23.25	2.46	0.55

Note: SD = Standard deviation, SE = Standard Error, BMI = Body Mass Index

Source: Test conducted in 2023 by the researcher

Table 1 showed the descriptive analysis of the physical characteristics of the participants used in this study. The mean age and corresponding standard deviation of the participants was 20.45±1.19 years, while the mean weight (kg), height (m), and BMI (kg/m^2) of the participants were 79.10±8.95kg, 1.84 ± 0.04 m, and 23.25 ± 2.46 (kg/m^2) respectively. The observation of the BMI classification revealed that the participants were within normal (23.25 kg/m^2) range.

Answers to Research Question and Test of Hypothesis

To answer and test the research question and null hypothesis, the data collected on the variable was analysed and presented using descriptive and inferential statistics accordingly.

Table 2: Descriptive Analysis of the Effect of Resistance Training on Aerobic Capacity (VO_{2max}) of Male Taekwondo Athletes of the Nigerian Army over the Period of Training

Variable	Test Period	N	Mean	SD	SEM
Aerobic Capacity (VO_{2max})	Base-line	20	18.55	1.06	.2385
	Week 4	20	17.52	1.10	.2478
	Week 8	20	15.93	1.07	.2395
	Week 12	20	14.21	0.88	.1971

Source: Test conducted in 2023 by the researcher

Table 2 presented the descriptive analysis of the data collected at base-line, immediately at the end of 4th, 8th and 12th weeks of resistance training on aerobic capacity (VO_{2max}) of male taekwondo athletes of the Nigerian Army. The data was assessed with 3.2 km run test against time. The results revealed the performance of the participants on aerobic capacity (VO_{2max}) using 3.2 km run test against time at base-line, at the end of 4th, 8th and 12th week of resistance training. The mean and standard deviations scores of the participants improved from 18.55 ± 1.06 to 17.52 ± 1.10 min, at the 4th week of resistance training. The results further revealed that at 8th and 12th week of resistance training, the performance of the participants also improved to 15.93 ± 1.07 and 14.21 ± 0.88 progressively. The results revealed an overall performance improvement of the participants with progressive decrease in mean time to complete 3.2 km run test aerobic capacity (VO_{2max}) after every four weeks of resistance training: which answered the research question one (1).

In order to test whether the progressive decrease in mean time to complete 3.2 km run test for aerobic capacity (VO_{2max}) after every four weeks of resistance training was statistically significant. The collected data were analysed using repeated-measures analysis of variance. The results are presented in Table 3 according to hypothesis 1

Sub-Hypothesis 1

There is no significant effect of RT on the aerobic capacity (VO_2 max) of male taekwondo athletes of the Nigerian Army.

Table 3: Repeated Measures Analysis of Variance on the Effect of Resistance Training on Aerobic Capacity of Male Taekwondo Athletes of the Nigerian Army

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Aerobic Capacity	Sphericity Assumed	216.077	3	72.026	996.363	.000
	Greenhouse-Geisser	216.077	1.717	125.817	996.363	.000
	Huynh-Feldt	216.077	1.872	115.444	996.363	.000
	Lower-bound	216.077	1.000	216.077	996.363	.000
Error (Aerobic_ capacity)	Sphericity Assumed	4.120	57	.072		
	Greenhouse-Geisser	4.120	32.630	.126		
	Huynh-Feldt	4.120	35.562	.116		
	Lower-bound	4.120	19.000	.217		

Source: SPSS data analysis output (p = 0.00)

Table 3 showed the results of repeated-measures analysis of variance on aerobic capacity (VO_2 max) of the participants. The results showed that resistance training has significant effect on aerobic capacity (VO_2 max) of the male taekwondo athletes of the Nigerian Army at 4th, 8th and 12th weeks of resistance training, respectively, with a progressive decrease in the time to complete 3.2km run test for aerobic capacity (VO_2max) (p = 0.000). Therefore, the null hypothesis which states that there is no significant effect of RT on the aerobic capacity (VO_2 max) of male Taekwondo athletes of the Nigerian Army was rejected.

In order to determine where the significant effect of the resistance training on aerobic capacity (VO_2 max) occurred, the Bonferroni post-hoc test was carried out and the result of the analysis is presented in Table 4 below:

Table 4: Summary of Bonferroni Post hoc Test Results for Differences in the Effect of Resistance Training on the Aerobic Capacity of Male Taekwondo Athletes of the Nigerian Army

(I) Aerobic Capacity	(J) Aerobic Capacity	Mean Difference (I-J)	Std. Error	Sig.[b]
Baseline	Week 4	1.025*	.047	.000
	Week 8	2.616*	.070	.000
	Week 12	4.339*	.113	.000
Week 4	Base-line	-1.025*	.047	.000
	Week 8	1.591*	.071	.000
	Week 12	3.314*	.111	.000
Week 8	Base-line	-2.616*	.070	.000
	Week 4	-1.591*	.071	.000
	Week 12	1.723*	.080	.000
Week 12	Base-line	-4.339*	.113	.000

(I) Aerobic Capacity	(J) Aerobic Capacity	Mean Difference (I-J)	Std. Error	Sig.[b]
	Week 4	-3.314*	.111	.000
	Week 8	-1.723*	.080	.000

**Source: SPSS data output. ***The mean difference is significant at the 0.05 level

The Bonferroni Post-hoc Test analysis on the effect of resistance training on aerobic capacity of participants in Table 4 above revealed significant improvement in the aerobic capacity of participants ($p = 0.000$), with mean decrease difference in the time to complete 3.2km run test for aerobic capacity efficiency of 1.025^*, 1.591^* and 1.723^* min, between the base-line and 4^{th} week, 4^{th} and 8^{th} week, 8^{th} and 12^{th} week, respectively. The result showed significant decrease in the 3.2km run test time for aerobic capacity efficiency of the participants at the end of every 4 weeks of resistance training. The highest decrease in the 3.2km run test time for aerobic capacity efficiency was between 8^{th} and 12^{th} week (1.723^*). Therefore, the null hypothesis was rejected.

DISCUSSION OF FINDINGS

The purpose of this study was to assess the effect of resistance training on aerobic capacity (VO_2 max) of male taekwondo athletes of the Nigerian Army. The results of hypothesis formulated and tested indicate that there was significant effect of resistance training on the biomotor ability variables of aerobic capacity (VO_2 max) of male taekwondo athletes of the Nigerian Army after 12 weeks of resistance training.

The result of the analysis showed that resistance training significantly enhanced aerobic capacity of male taekwondo athletes of the Nigerian Army at the end of 4^{th}, 8^{th} and 12^{th} weeks of training. The significant enhancement in the aerobic capacity may be attributed to increase in muscle mass, which in turn lead to an increase in the number of mitochondria within the muscle cells. Mitochondria are the cellular organelles that are responsible for producing energy, and more mitochondria mean more energy production (Paoli, Gentil, Moro, Marcolin, & Bianco, 2017). This enhanced energy production capacity means that the muscles were able to contract harder and longer during physical exertion, which lead to an increase in aerobic capacity (Parry, Roberts, & Kavazis, 2020).

Furthermore, Huertas, Casuso, Agustín, and Cogliati (2019) reported that the increase in muscle fibre size results in a greater number of mitochondria, which are responsible for the conversion of oxygen to adenosine triphosphate (ATP) during exercise. Similarly, Hoppeler (2016) ascertained that there is an increase in the activities of oxidative enzymes, which are responsible for the conversion of oxygen and nutrients into energy within the mitochondria of muscle cells. The improved oxygen utilization evident by a significant increase in VO_2Max consumption during the prolong physical activity was obtained in the present study and it demand optimal utilization of oxygen, which in turn enhanced the aerobic capacity of the taekwondo athletes. This finding was in line with the study of Hargreaves and Spriet (2020), who reported that resistance training also leads to an increase in muscle fibre recruitment during exercise. This means that more muscle fibres are activated during physical activity, which leads to a greater demand for oxygen utilization and ultimately an increase in aerobic capacity. The result of the present study is also similar to the findings of Tsitkanou, Spengos, Stasinaki, Zaras, Bogdanis, Papadimas, and Terzis (2017), who revealed that resistance training increases capillary density within the muscles, and improves the delivery of oxygen to the muscles during exercise and therefore, improves aerobic capacity of taekwondo athletes. Therefore, enhanced aerobic capacity through an ideal resistance training is effective in enhancing the aerobic capacity of Nigerian Army male taekwondo athletes, thus enhancing the athlete ability to sustain the high intensity and intermittent nature of taekwondo training and competitions proficiently without the setting in of undue fatigue.

CONCLUSION

Based on the findings of this study, the researcher concluded that Resistance training at 50-70% of 1 RM exerted significant effect on the aerobic capacity (VO_2 max) of male taekwondo athletes of the Nigerian Army.

RECOMMENDATION

On basis of the research conclusion, the researcher recommended that the Nigerian Army taekwondo coaches and athletes should ensure that resistance training between 70-90% of 1 RM and periodic biomotor abilities evaluation should be integrated into their comprehensive fitness training regimen in order to enhance the Nigerian Army male taekwondo athletes' aerobic capacity (VO_2 max) for performance proficiency in training and competitions.

REFERENCES

American College of Sports Medicine (2020). American college of sports medicine position stand. Progression models in resistance training for healthy adults. *Medicine and Science in Sports and Exercise,* 1(317): 634-781.

Barley, O. R., Chapman, D. W., Guppy, S. N., & Abbiss, C. R. (2019). Considerations when assessing endurance in combat sport athletes. *Frontiers in physiology, 10*, 205.

Bridge, C. A., Ferreira da Silva Santos, J., Chaabene, H., Pieter, W., & Franchini, E. (2014). Physical and physiological profiles of taekwondo athletes. *Sports Medicine, 44*, 713-733.

Cipryan, L., Tschakert, G., & Hofmann, P. (2017). Acute and post-exercise physiological responses to high-intensity interval training in endurance and sprint athletes. *Journal of sports science & medicine, 16*(2), 219.

Cohen, L., Manion, L., & Morrison, K. (2007). Observation. *Research methods in education, 6*, 396-412.

Davies, T. B., Tran, D. L., Hogan, C. M., Haff, G. G., & Latella, C. (2021). Chronic Effects of Altering Resistance Training Set Configurations Using Cluster Sets: A Systematic Review and Meta-Analysis. *Sports Medicine, 51*(4), 707-736. doi:10.1007/s40279-020-01408-3

Diogo, L. M., Henrique, P.N., Daniel, A. M. & Mario, C.M. (2020). Novel resistance training approach to monitoring the volume in older adults: The role of movement velocity. *International Journal of Environmental Respond to Public Health,* 17(20): 755-763.

Ferreira da Silva Santos, J., Herrera-Valenzuela, T., & Franchini, E. (2019). Establishing frequency speed of kick test classificatory tables in male and female taekwondo athletes. *Kinesiology, 51*(2.), 213-218.

Fort-Vanmeerhaeghe, A., Romero-Rodriguez, D., Lloyd, R. S., Kushner, A., & Myer, G. D. (2016). Integrative neuromuscular training in youth athletes. Part II: Strategies to prevent injuries and improve performance. *Strength and Conditioning Journal, 38*(4), 9-27.

Fragala, M. S., Cadore, E. L., Dargo, S., Izquierdo, M., Kreamer, W. J., Peterson. M.D., Ryan, E. D. (2019). Resistance training for older adults : Position statement from the national strength and condition association. *Journal of Strength and Conditioning Research,* 33 (8): 2019-2052.

Gabar, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Lee, I. M. (2011). American college of sports medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Medicine and Science in Sports and Exercise,* 43(7): 1334-1359.

Granacher, U., Lesinski, M., Büsch, D., Muehlbauer, T., Prieske, O., Puta, C., . . . Behm, D. G. (2016). Effects of resistance training in youth athletes on muscular fitness and athletic performance: a conceptual model for long-term athlete development. *Frontiers in physiology, 7*, 164.

Haff, G. & Triplet, T. (2016). *Essential of Strength Training and Conditioning,* Forth Edition. Champaign: Human Kinetics. US. Pp. 148-152.

Hargreaves, M., & Spriet, L. L. (2020). Skeletal muscle energy metabolism during exercise. *Nature Metabolism, 2*(9), 817-828.

Hoppeler, H. (2016). Molecular networks in skeletal muscle plasticity. *Journal of Experimental Biology, 219*(2), 205-213.

Huertas, J. R., Casuso, R. A., Agustín, P. H., & Cogliati, S. (2019). Stay fit, stay young: mitochondria in movement: the role of exercise in the new mitochondrial paradigm. *Oxidative Medicine and Cellular Longevity, 2019*.

Nigerian Taekwondo Federation (2023). National Taekwondo Ranking.

Nunes, J. P., Grgic, J., Cunha, P. M., Ribeiro, A. S., Schoenfeld, B. J., de Salles, B. F., & Cyrino, E. S. (2021). What influence does resistance exercise order have on muscular strength gains and muscle hypertrophy? A systematic review and meta-analysis. *European journal of sport science, 21*(2), 149-157.

Paoli, A., Gentil, P., Moro, T., Marcolin, G., & Bianco, A. (2017). Resistance training with single vs. multi-joint exercises at equal total load volume: effects on body composition, cardiorespiratory fitness, and muscle strength. *Frontiers in physiology, 8*, 1105.

Parry, H. A., Roberts, M. D., & Kavazis, A. N. (2020). Human skeletal muscle mitochondrial adaptations following resistance exercise training. *International Journal of Sports Medicine, 41*(06), 349-359.

Rahman, N., & Siswantoyo, S. (2018). An exercise model to develop the biomotor ability of endurance in teenage martial arts athletes. In *Character Education for 21st Century Global Citizens* (pp. 517-524): Routledge.

Rahmani-Nia, F., et al. (2020). Anthropometric and biomotor characteristics as correlates of competitive performance in Iranian young male taekwondo athletes. *Journal of sports medicine and physical fitness, 60(5)*, 727-734.

Raj, J. P., D'Cruz, J. M., Toms, T., Muralidharan, P., & Rao, M. (2018). Physical endurance enhancing capacity of Withania somnifera root powder post-water extraction in mice. *Pharmacognosy Research, 10*(3).

Ryan Chong, W. L. (2018). *Reliability and validity of a taekwondo electronic body protector/Ryan Chong Wy Lunn*. University of Malaya,

Tomkinson, G. R., Lang, J. J., Blanchard, J., Léger, L. A., & Tremblay, M. S. (2019). The 20-m shuttle run: assessment and interpretation of data in relation to youth aerobic fitness and health. *Pediatric exercise science, 31*(2), 152-163.

Tornello, F., Capranica, L., Minganti, C., Chiodo, S., Condello, G., & Tessitore, A. (2014). Technical-tactical analysis of youth Olympic Taekwondo combat. *The Journal of Strength & Conditioning Research, 28*(4), 1151-1157.

Tsitkanou, S., Spengos, K., Stasinaki, A. N., Zaras, N., Bogdanis, G., Papadimas, G., & Terzis, G. (2017). Effects of high-intensity interval cycling performed after resistance training on muscle strength and hypertrophy. *Scandinavian journal of medicine & science in sports, 27*(11), 1317-1327.

Wolff, W., Bieleke, M., & Schüler, J. (2019). Goal striving and endurance performance. In *Endurance Performance in Sport* (pp. 125-137): Routledge.

Zhao, K., Hohmann, A., Chang, Y., Zhang, B., Pion, J., & Gao, B. (2019). Physiological, anthropometric, and motor characteristics of elite Chinese youth athletes from six different sports. *Frontiers in physiology, 10*, 405.