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Assessment of Moderate Altitude Training on Speed Endurance among Amateur Distance Athletes in Plateau State, Nigeria

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Abstract:- The study was designed to assess the effects of 3 weeks moderate altitude training on speed endurance among male amateur distance athletes in Plateau State, Nigeria. This is against the fact that current records show a discouraging weak performance among endurance athletes in Plateau state. The study was significant to the athletes' hence it has the potential of improving their speed endurance for further competitions at national and international level. Coaches can also benefit from this study in the area of designing and executing training programme. Pankshin which is located at an altitude of 1414 m above sea level was used as the venue of the study. A 1 x 4 x 1 factorial research design was used for the study. The purposive sampling technique was used to select 15 out of the 20 amateur distance runners who are dwellers of Shendam located at a low altitude of 289 m above sea level on the basis of their performance in a VO_2 max. test. Training was maintained between 60-80% of maximal heart rate of individual runners on daily basis for duration of 3 weeks. All training sessions was conducted between 7.00am – 8.30 am and 4.30pm -6.00 pm daily. The daily training programmes included road running (6-12km) hill training that consisted of five repetitions of 200 m and interval sprint training on a cinder track. The participants speed endurance were assessed at baseline, immediately after the first, second and third weeks of training. Descriptive statistics of mean, standard deviation and standard error of estimate were used to analyze the physical characteristics and performance scores of the participants. The inferential statistics of repeated measures analysis of variance were used to test the hypothesis at an alpha level of 0.05. the result revealed that moderate altitude training significantly improved (P = 0.000) the speed endurance of amateur distance runners in Plateau State. It was recommended that amateur distance runner's should be exposed to altitude and other endurance related training programmes by coaches and relevant agencies in Plateau state to further equipped them for better performance at national and international competitions.

Keywords:- *Altitude, distance, amateur, performance, endurance, athletes, acclimatization, speed, competition and training.*

I. INTRODUCTION

An altitude is any elevation above sea level, characterised with diminishing oxygen availability due to low barometric pressure, thus, there is this reduction in partial pressure of oxygen (PO_2) on ascent to high altitude which leads to decreased tissue oxygenation. Exposure to extreme environmental conditions has been recognized as a type of stress to the cardiovascular system that alters oxygen uptake and other bodily functions of athletes. Therefore, the cardiovascular system must undergo substantial changes at altitude to compensate for the decreases in partial pressure of oxygen (PO_2) that accompanied increased altitude ascent (Wilmore & Costil, 2004; Adias, Escudero, Jackeline, Shailendra& Richard, 2012).

Altitude training is a practice by endurance athletes who trained for several weeks at an elevation above sea level (altitude environment) though more commonly at moderate altitude of between 800 m – 2400 m above sea level. At moderate altitude, the air contains approximately 20.9% oxygen of the barometric pressure, thus, the partial pressure of oxygen is reduced, depending very much on the protocols used, the body may acclimatize to the relative lack of oxygen in one or more ways, such as increasing the mass of red blood cells and haemoglobin or altering muscle metabolism (Rusko, Tikkanen & Peltonen, 2014). It has been observed that upon exposure to altitude, endurance athletes do face series of physiological and performance challenges as they experience acute variation of barometric pressure. For instance, some of these immediate physiological changes include: insomnia, nausea, breathlessness, headache, dizziness, arterial oxygen saturation, increased heart rate, increased pulmonary ventilation to meet the oxygen demand, decreased pulmonary oxygen diffusion and decreased blood volume, which lead to an immediate increase in red blood cell concentration (haematocrit). This aids oxygen delivery to tissues, increased cardiac output, decreased VO_2 max and ameliorate acute mountain sickness (Brooks & Fahey, 2004; McArdle, Katch, & Katch, 2010).

Muza, Fulco and Cymerman (2016), maintained that exposure to altitude could practically improve athlete's speed endurance performance only with acclimatization and correct training loads. Exposure to moderate or high altitude camps cause the body to acclimatize to the lower level of oxygen available in the atmosphere. One of the changes that occur with acclimatization is improved oxygen delivery to the muscles, and that more oxygen is theorized to enhance

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endurance performance in athletes. Research evidence shows that moderate altitude training does not affect the performance of athletes in explosive events like short sprints up to 400 m; long jump or triple jump events because the reduction in atmospheric pressure means that there is less resistance from the atmosphere and the performance of these athletes are generally observed to be better. However, endurance performance in events from 800 m and above is negatively affected at moderate altitude. This is theorized to be due to low oxygen to the tissues, which generally reduces the athletes' performance until when they get acclimatized and adapt to the low oxygen level of the environment. Endurance athletes can take advantage of moderate altitude acclimatization to increase performance when the body copes positively with moderate altitude exposure and training. This coping is most likely to help towards increasing performance at sea level. Research evidence and records have shown that most endurance athletes from Kanya, Uganda and Ethiopia are great beneficiaries of this type of training, for instance Joshua Chaptegei of Uganda with the record time of 12:35.36 in 5000m race, Daniel Kmem of Kenya with a world record of 7:20.67 in 300m and Eliud Kipchoge of Kenya with a record of 2:01:09 in Marathon race.

Plateau State is located in the North Central part of Nigeria with a favourable weather condition having means annual ambient temperature values of between 21ºC and 27ºC. It is classified as one of the coolest areas in the country, characterized by cool and favourable weather conditions, particularly in the Northern and Central Senatorial zones, with mean annual ambient temperature values of between 20ºC and 25ºC in Jos and Pankshin, while the Southern Senatorial zone has a warm and hot climatic weather with mean annual ambient temperature value of over 27ºC in Shendam, similar to the weather conditions of Niger and Benue lowlands. Furthermore, the Northern and central Senatorial zones of the State have elevations of between 1,280 m and 1,650 m above sea level as found in Kuru, Naraguta, Pankshin and Shere Hills, while the Southern zone has 289 m above sea level in Shendam (Iloeje, 1981). Therefore, Pankshin which is found within the Central Senatorial zone with an elevation of 1414 m above sea level and considered a moderate altitude environment will be used for the study as the venue.

Several studies have revealed that different training techniques at altitude have great advantage on athletes' performance, at sea level on physiological changes. Mclean, Vargas & Recibide (2013), reported that a pre-season training camp at 2100m altitude produced 1.5% improvement in 2000 m running performance.

It has been observed that athletes normally seek for competitive advantage through various strategies. Although the benefits of some interventions are clear, most strategies are less well proven, altitude is no exception to this. Training at high and moderate altitude has been used by competitive athletes as a means of improving their potentials and performance. Despite a good deal of research into this topic, its true effects and recommended approaches are not well established locally, among coaches in Nigeria. It is on this bases that the researchers intends to establish the true effects of altitude training in Nigeria.

Plateau State of Nigeria, with moderate altitude in most parts and whose athletes are expected to utilize this advantage at National and International competitions, has always been the opposite as records shows discouraging weak performances at most times. This could be confirmed with the just concluded 2022 Delta National Sport Festival where Plateau State could not win any Gold medal in long distance races. It is a known fact that application of altitude training to enhance functional reserves, training capacity and performance of athletes have become extremely popular the world over. The results of physiological, biochemical and methodological experiments, which reported the efficacy of altitude training to enhance performance at sea level have been inconsistent, inconclusive and sometimes controversial. It is in view of these observations that the researchers were interested in carrying out this study to enable them examine the effects of moderate altitude training on speed endurance among male amateur distance athletes in Plateau State of Nigeria and to determine whether there could be any significant difference in the performance of the athletes being subjected to training at moderate altitude in their speed endurance. It is not disputable that the concern of exercise scientists and sports professionals is to ensure performance enhancement in all sectors of the sports industry. This is achievable through more effective and efficient training methods, such as the correct application of altitude training, improved methods of selecting athletes and extrinsic rewards among others. Research evidence shows that altitude training is of competitive advantage, although it is also clear that its true effects and recommended approaches are not very clear and controversial. The study is planned to assess the performance trends of amateur distance runners to moderate altitude exposure.

It is in view of this challenges highlighted above that the researchers were motivated to carry out this study to establish whether competitive advantage will be evidenced after a short duration stay at moderate altitude.

II. RESEARCH QUESTION

What is the effect of moderate altitude training on speed endurance among male amateur distance athletes in Plateau state, Nigeria?

III. HYPOTHESIS

There is no significant effect of moderate altitude training on speed endurance among male amateur distance athletes in Plateau state, Nigeria.

IV. METHODOLOGY

A. Research Design

A 1 x4 x1 factorial research design was used for this study. In this design moderate altitude environment was used for the study, four levels of assessment were conducted at baseline, end of first, second and third week of training on one variable. This design was considered more appropriate

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because only one environment was used for the study with four levels of assessment for data collection on one variable.

B. Population

The population for this study consists of twenty (20) male amateur distance runners of Plateau State, Nigeria who are dwellers of Shendam in the Southern part of the State (Plateau State Sport Council, 2022).

C. Sample

A purposeful sampling technique was adopted to select fifteen (15) out of 20 amateur distance runners based on their closed VO_2 max, who were dwellers of low altitude environment (Shendam) from the southern senatorial part of the state after a 12 minutes run test.

D. Instrumentation

The following facilities and equipment were used for the study;

- A standard 400m track
- Hilltop road Pankshin (650 m)
- Whistles
- Electronic stop watches

E. Training Protocols and Programme

The training programme used was the interval training, which consisted of running and other resistance activities. Daily training programme was executed in the mornings and evenings for a period of three weeks at moderate altitude. Before the execution of any training schedule, 10 minutes was used for general warm-up exercises, which composed mainly of stretching activities to prepare the athletes. An example of training schedule, which is shown on the Table of the training programme below for the entire training period is the (4 x 2 x 400 m) 65" (3'/5') adopted from IAAF (2009): The interpretation of this programme implies that two repetitions of 400 m running at an intensity (space) of 65 Sec. with a recovery period of 3 minutes with 5 minutes rest between 4 sets. The schedules of the programme were alternated between heavy and light rhythms of training as suggested by Bompai (2016) and Venkateswarlu (2010) to allow time for recovery and better output. The training venue was in Pankshin, which has an altitude of 1414 m above sea level which is considered as a moderate altitude environment. (Iloeje, 1981; Akindele & Olutayo, 2017).

Table 1: Schedule of the training Programme

Week1	**Morning (am)**	**Evening (pm)**	**Intensity**	**Executors/participant**
Day 1	5-8km slow pace run	5 x 1200 m) 2' (5')	60% max. heart rate	Researchers and athletes
Day 2	Hill training of (200 m x 5) at 35"(40")	4 x 2 x 400 m) 65" (3'/5')	65% max. heart rate	Researchers and athletes
Day 3	6-10km road work at 70% $V0_2$max. (35')	6x200m) 36" (2')	60% max. heart rate	Researchers and athletes
Day 4	weight training 30kg 8-12 repetition 4-6 sets	20-30 minutes diagonal run on a football pitch	70% max. heart rate	Researchers and athletes
Day 5	2 x 3 x 300 m (400 m pace) 40"(3'/5')	3 x 6 x 150 m) 20" (1'/3')	60% max. heart rate	Researchers and athletes
Day 6	Trials and assessment		80% max. heart rate	Researchers and athletes
Week 2	**Morning (am)**	**Evening (pm)**	**Intensity**	
Day 1	8km fast road work at 65% $V0_2$max.	3x3x450 m)70"(2'/5')	70% max. heart rate	Researchers and athletes
Day 2	2 x 5 x 500) (5000 m pace) 1½'/4'	2x3x300 m (300 m pace) 40" (2'/5')	65% max. heart rate	Researchers and athletes
Day 3	12km steady run marathon pace (40')	2x2x1000 m) 5000 m pace (1½'/5')	70% max. heart rate	Researchers and athletes
Day 4	40-50mins. Continues run at 60% $V0_2$max.	3x4x200 m) 30" (3'/4')	65% max. heart rate	Researchers and athletes
Day 5	12 km long road work (40')	stretching exercises 150 m x 8 (20")	65% max. heart rate	Researchers and athletes
Day 6	Trials and assessment		80% max. heart rate	Researchers and athletes
Week 3	**Morning (am)**	**Evening (pm)**	**Intensity**	
Day 1	8 km fast road work	3x3x500 m (<3000 m pace) (45'and 5')	75% max. heart rate	Researchers and athletes
Day 2	Hill training 120 m x 5/25"	2x4x200 m at 90% $V0_2$max. (30" and 4')	65% max. heart rate	Researchers and athletes
Day 3	3x5x400 m) 70-75" (4')	100 m curve and straight run 10 each (10x4 = 40 times)	75% max. heart rate	Researchers and athletes
Day 4	2x6x150 m) 24" (1'/3')	30-50 minutes continues run on grass	75% max. heart rate	Researchers and athletes
Day 5	8x300 m) 36" (40")	stretching exercises	70% max. heart rate	Researchers and athletes

		10 x 100 m) 15”		
Day 6	Trials and assessment		80% max. heart rate	Researchers and athletes

Source: IAAF (2009)

F. Procedure for Data Collection

Participants were subjected to 5,000 m long distance race to determine their speed endurance. Stop watches were used to determine the finishing time of the participants. This was done before the commencement of training (baseline), at the end of training in weeks one (1), two(2) and three(3), between 7:00 am and 8:30 am on the assessment days.

V. RESULT

The physical characteristics of participants at base-line, immediately after the first, second and third week of training are presented below;

Table 2: Mean, Standard deviation and standard error of estimate of the age, weight (kg), height (m) and body mass index (kg/m^2) of the participants at base-line, immediately after the first, Second and third week of training at moderate altitude:

Table 2: Moderate Altitude

Duration	Variable	Mean	SD	SE
Baseline	Age (year)	18.866	1.959	.506
	Weight (kg)	55.866	8.245	2.128
	Height (m)	1.636	.03043	.0076
	BMI (kg/m^2)	20.771	2.835	.732
1st week	Weight (kg)	55.066	8.030	2.073
	BMI (kg/m^2)	20.300	2.619	.676
2nd week	Weight (kg)	54.066	7.869	2.031
	BMI (kg/m^2)	20.066	2.605	.672
3rd week	Weight (kg)	52.933	7.439	1.920
	BMI (kg/m^2)	19.644	2.426	.626

Male distance runners used for this study were 18.87±1.96 years old with mean body weight of 55.87 ± 8.25 kg; 1.64 ± 030.43m in height and BMI of 20.77 ± 2.84 kg/m^2. As training progressed the mean weight and BMI decreased after the first week to 55.066 ± 8.030 kg and 20.300 ± 2.619 kg/m^2 respectively. Further decrease was observed in the 2nd week with a weight mean and BMI of 54.066 ± 7.869 kg and 20.066± 2.605 kg/m^2 respectively. At the end of the third week of training, marked decrease was noticed in the mean weight (52.933 ± 7.439 kg) and BMI (19.644 ± 2.426 kg/m^2).

Table 3: Descriptive statistics of mean, standard deviation and standard error of mean on speed endurance of distance runners at moderate altitude

Variable	Altitude	MODERATE			
	Duration	N	Mean	SD	SE
Speed Endurance	Baseline	15	20.346	2.518	.650
	Week 1	15	19.554	1.751	.452
	Week 2	15	19.110	1.490	.384
	Week 3	15	18.804	1.348	.348
	Average		19.454	1. 879	.242

Table 3 shows the mean, standard deviation and standard error of mean of the speed endurance performance of amateur distance runners in Plateau State, Nigeria at moderate altitude at baseline, immediately after the 1st, 2nd and 3rd week of training. An observation of the table showed that the participants’ performance improved with weekly training and adaptation from 20.35±2.52 minutes on arrival to 18.80±1.35 minutes at the end of the 3rd week.

In order to find out whether the improvement in speed endurance at moderate altitude was statistically significant, the data were analyzed using repeated measures analysis of variance (ANOVA), the result of which is presented below;

Table 4: Repeated Measures Analysis of Variance on speed endurance of amateur distance runners at moderate altitude

Altitude		Source	SS	DF	MS	F	Sig.
	Time	Sphericity assumed	20.225	3	6.742	11.548	.000
		Green house-Geisser	20.225	1.396	14.489	11.548	.001
		Huynh-Feldt	20.225	1.503	13.461	11.548	.001
Moderate		Lower bound	20.225	1.000	20.225	11.548	.004
	Error	Sphericity assumed	24.520	42	.584		
	(Time)	Green house-Geisser	24.520	19.542	1.255		

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Huynh-Feldt	24.520	21.036	1.166
Lower bound	24.520	14.000	1.751

Sig. at .05

Table 4 shows repeated-measures analysis of variance (ANOVA) on speed endurance of amateur distance runners at moderate altitude in Plateau State, Nigeria. An observation of the analysis showed that training caused significant improvement on the speed endurance of the participants as revealed in the sphericity assumed. Further observation of the table revealed significant effect with P values less than 0.05 (P = 0.000). Therefore, the null hypothesis which states that there is no significant effect of moderate altitude training on speed endurance of amateur distance runners of Plateau State, Nigeria is hereby rejected.

To establish which phases of training was responsible for the significant difference, *Post-hoc* least square difference (LSD) tests for multiple comparison was applied on the means at baseline, 1st, 2nd and 3rd week at moderate altitude and the results is presented below;

Table 5: Results of *post-hoc* LSD tests on speed endurance of amateur Distance runners at moderate altitude:

Experimental group at moderate altitude	Mean difference (i-j)	SE	Sig.	95% Confidence interval	
				Lower bound	Upper bound
Baseline					
Week 1	.79200	.669	.242	-.549	2.133
Week 2	1.236	.669	.070	-.105	2.577
week 3	1.542*	.669	.025	.200	2.883
Baseline					
Week 1	-.792	.669	.242	-2.133	.549
Week 2	.444	.669	.510	-.897	1.785
week 3	.750	.669	.267	-.591	2.091

Significant at 3rd week

Table 5 shows that the significant difference was revealed at the 3rd week of training with P value less than 0.05. Further illustration of the result is hereby shown in figure A below.

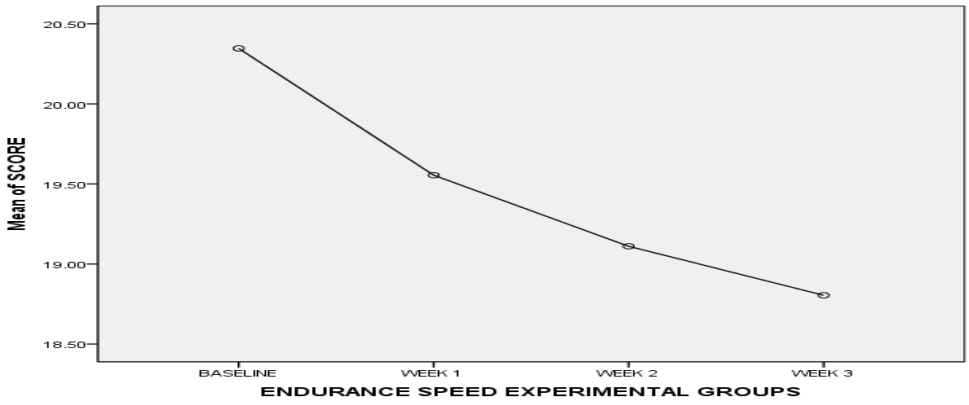

Fig. 1: Means speed endurance of the participants at moderate attitude

VI. DISCUSSION

The results of this study also revealed a significant reduction in the performance speed in 5000m finishing time of the participants from the baseline through the period of stay at moderate altitude. Speed endurance value of 20.346 minute reduced to 19.554 Sec., 19.110 Sec. and 18.804 Sec. after the first, second and third week of stay respectively. This improvement was confirmed to be statistically significant (P=0.000). The result is in agreement with the findings of Rusko *et al.*,(2014) and Muza *et al.*, (2014), who maintained that exposure to altitude could theoretically improves athletes capacity to enhance performance with acclimatization and correct training loads. With altitude and training acclimatization, improved delivery of oxygen to the muscle is achieved and more oxygen is theorized to enhance endurance performance. The result also agrees with Mortan and Cable (2015) who maintain that, though endurance performance drops in athletes immediately on ascent to altitude, it improves significantly with acclimatization. Contrary to this report, Miller (2014) remarked that the higher the altitude the more athletic performance drops off due to the climatic changes at high altitude which consequently affects performance. However, it is important to note that this position is presented without considering the acclimatization process. The mechanisms for this improvement could probably be due to the athletes ability to cope with the increasing work intensity and oxygen/energy demands. The result is also in line with Mazzeo (2018); Morton and Cable (2015) who maintained that a 3-week duration stay at altitude could be beneficial to endurance athletes.

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VII. CONCLUSION

Based on the finding of this study, it is concluded that moderate altitude training significantly improved (P = 0.000) the speed endurance of amateur distance runners in Plateau State, Nigeria from base-line values of 20.346 minute reduced to 19.554 Sec., 19.110 Sec. and 18.804 Sec. after the first, second and third week of training respectively.

VIII. RECOMMENDATION

Based on the finding of this study, the following recommendation are hereby made;

- Amateur distance runner's should be exposed to altitude and other endurance related training programmes by coaches and other relevant training agencies in Plateau state for improved performance at national and international competitions.
- Coaches should also be exposed to performance enhancement training techniques such as altitude training to further improve their capacities.

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