Effects of Repetition Training and New Interval Training Methods on Anaerobic Fitness: In the Case of Short and Middle-Distance Athletes

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***Abstract*- The purpose of the study is to compare the effects of new interval training methods and repetition training methods on short- and middle-distance athlete's anaerobic fitness. Thirty (30) short and middle-distance project athletes were selected comprehensively from the total of 40 athletes. Based on the pretest result, the subjects were randomly assigned to the repetition (n = 15) and new interval (n = 15) training groups. The study design was quasi-experimental. So as to measure the effect of the training, five anaerobic fitness tests, viz., the 400-meter drop-off test, the 150-metre endurance test, the 30-metre flying test, and the RAST test, was measured. To evaluate the effect of these training methods and whether there was a significant difference between pre- and post-intervention results after 8 weeks of three days per training intervention week, a paired sample t test was employed. In addition, to examine differences between the two groups results on anaerobic fitness, an independent sample t-test with an alpha value of 0.05 was employed. Both training methods have a significant effect on anaerobic efficiency, speed endurance, maximum speed, power, and fatigue index as measured pre- and post-test. There was a significant difference between the repetition training group and the new interval training group in terms of anaerobic efficiency (p =.020, MD =.807) and maximum speed (P =.008, MD =.448). There was no significant difference between the two groups in the level of speed endurance (p = 0.150), power (p = 0.619), or fatigue index (p = 0.788). Therefore, two months of both the new interval training method and the repetition training method were effective for the improvement in all the above-mentioned fitness variables. The repetition-training method is better than the new interval-training method in improving anaerobic efficiency and maximum speed, but there was no significant difference between groups in speed endurance, power, or fatigue index. Therefore, it would seem highly recommended to implement both repetition and new interval training programmes to improve anaerobic fitness, and repetition training should be more effective than new interval training.**

***Key Words*— Anaerobic Fitness, Repetition Training, New Interval Training, Athletes, Short distance & middle distance**

I. INTRODUCTION

To train athletes, a coach must understand the basic principles that govern a human being's physical and mental response to training. Intelligently and systematically applying a basic knowledge of biomechanics and physiology helps create good track and field athletes. The training a coach devises will become a recipe that combines conditioning, mobility and flexibility training, strength and plyometric training, and specific event technique. Only in this way does optimum performance become a matter of planning, not happenstance.

To provide a fitness foundation for all athletes and later to develop the specific fitness required for an event, it is necessary for the coach to understand the characteristics of fitness and how to develop them. A large number of interrelated factors can determine success in sports. Among these, training is the most decisive factor, which directly influences the improvement of an athlete's performance (Laursen & Jenkins, 2002). Training is a programme of exercises designed to improve the skills and increase the energy capacities of an athlete for a particular event (Edward et al., 2007). Training is a systematic process with the objective of improving an athlete's fitness in a selected activity. A long-term process is progressive and recognises the individual athlete's needs and capabilities. Hardial (1991) also strengthens this concept, as sports training is a pedagogical process based on scientific principles aiming at preparing athletes for higher performances in sports competitions.

The primary purpose of any training programme is to optimise an athlete's performance during training and competition. To accomplish this goal, coaches and athletes should design and implement comprehensive training programmes that help athletes meet the physiological demands of a specific event (Cathal, 2013). The amount of the training response depends on different factors, like the duration of the exercise bouts, their intensity, the frequency and recovery activities between intervals at which they are performed, the initial training status of athletes, their genetic potential, and the age and gender of the individual (Wenger & Bell, 1986).

Therefore, specifying an optimal training regimen for an athlete's fitness improvement requires knowledge of applying different training methods for physiological adaptations (Helgerud et al., 2007). Perhaps most importantly, the coach must understand what adaptations will occur in response to the various forms of training available. Improvements in performance are generally a result of higher levels of fitness. This fitness comes from an improved understanding by coaches and athletes of training and its effects.

Regarding different training methods for the development of anaerobic fitness, various researchers made different suggestions. According to Thorson (2013); interval training with the pace of 95%-100% of Vo2 max or 97% to 100% of your max heart rate –5 min max have a benefit to: Maximise aerobic power (VO2 max). Increase lactic threshold levels. It improves your ability to run harder and longer without going into oxygen debt. Increases endurance, which means that the runner can continue at a certain pace for a longer period of time. Builds muscle strength. Whereas repetition training at a pace of 105–120% of VO2 max for 2 minutes at a maximum has the benefit of improving the anaerobic glycolytic system, power, speed, and economy.

The other researcher, Gordon (2009), confirms that the most suitable training method for the improvement of anaerobic parameters is through the use of intervals of duration between 60 and 240 s at about 90–95 percent of peak speed. Supporting this idea, Draper and Hodgson (2008) stated that anaerobic training leads to improvements in glycolytic metabolic functioning and fatigue resistance. Interval training with high intensity and short recovery is perhaps the single most useful method for improving anaerobic endurance capacity. The result of this research also indicated that the physiological adaptation to anaerobic endurance training will increase glycogen uptake during recovery, increase resting glycogen stores, improve glycolytic enzyme activity, increase buffering capability, increase tolerance of H+, and even produce small improvements in aerobic metabolism.

The purpose of the present study was to compare the effect of new interval training and repetition-training methods on athletes anaerobic fitness in the case of the Tilili Athletics Project. Throughout the process of designing appropriate training methods for adaptations of specific physiological fitness parameters, it is important to know how these training methods should deliver and produce improvement in an athlete's performance with the least amount of effort (Daniel, 2018).

Among various training methods, repetition and new interval training methods are commonly used to improve an athlete's anaerobic fitness. According to Gordon (2009), for the improvement of anaerobic parameters, the most suitable training method is using intervals of duration between 60 and 240 s at about 90–95 percent of peak speed. Therefore, many of the interval sessions employed in the development of endurance or team athletes will be for the development of anaerobic capacity.

It is already proven that interval training and repetition training are effective methods for improving performance in athletics. Even though the result of most studies shows that both interval and repetition training methods are equally effective in improving anaerobic capacity (Tirkey, 2014**;** Pandey & Verma, 2016), there is little study of interval training methods with active recovery (roll-on). Tilili athletics centre has its own athletic club and project, and it contains above 100 athletes: 70 project athletes (40 U-17 and 30 U-13) and 30 club athletes. This athletic centre has been the source of nationally and internationally competent athletes since 2004 E.C. The researcher had a chance to attend and follow the training processes, which are performed by the coaches and athletes of the athletic centres. A researcher attended not only Tilili athletic centre but also other athletic training centres like Belayneh Kinde athletic project, Birhan athletics project, Injibara athletics project, Sekela athletics project, Fagita athletics project, Awilma athletics project, and the like. However, as a researcher observed and tested during taking a coaching practise course at the project, the athletes had many anaerobic fitness problems, which they faced in competition as well as during training.

II. Material and Methods

A quasi-experimental research design methodology was used to assess the impact of repetition and novel interval training techniques on athletes' anaerobic fitness because the study was experimental in nature. Quantitative methods of data analysis were chosen because they enable the researcher to explore, assess, and analyze the impacts of repetition training and new interval training techniques on athletes' anaerobic fitness.

According to the purpose of the study, the researchers employed both primary and reference sources. The main data came from field pre- and post-test measures conducted at the start and conclusion of the training session. The relevant references were gathered from a variety of sources, including books, journals, articles, thesis papers, and online sites, in order to gather adequate and pertinent data connected to the study field.

Study Location: Tilili athletics center, Guagusa shegudad district, Awi Administration Zone, Amhara Regional State, Ethiopia.

Study Duration: November 2019 to June 2020.

Sample size: 30 U-17 projects, short and middle-distance runners of the project athletes. The study comprises 11 short-distance athletes (7 males and 4 females) and 19 middle-distance athletes (11 males and 8 females).

Subjects & selection method: Because the researcher grew up in the area and anaerobic fitness issues were more prevalent there, the Tilili athletics study was chosen using a purposeful sample strategy out of all the sports projects in the Amhara region. The Tilili Athletics Center offers a dedicated sports club as well as under-17 and under-13 initiatives (U-13). The U-17 Project has been purposefully chosen by the researcher from this target population because project athletes have been exposed to the highest opportunities for fitness improvement.

Procedure methodology

The researcher employed the following anaerobic fitness tests to determine anaerobic fitness variables before and after training interventions: anaerobic efficiency, speed endurance, maximum speed, average power, and fatigue index.

• Running-based Anaerobic Sprint Test (RAST), 400-meter Drop Off Test, 150-meter Endurance Test, and 30-meter Flying Test

The types of data sources used in the study were pretests and posttests. The stated problem needs to be measured for anaerobic fitness variables to evaluate the comparative effects of repetition and new interval training. In the project level, field-based fitness tests are a practical and feasible option to assess the physical fitness variable. Field-based fitness tests are easy to administer, involve minimal equipment, are low cost, and a larger number of participants can be evaluated in a relatively short period of time. The field tests consisted of: 1) power and fatigue index (RAST test in watts/second), 2) anaerobic efficiency (400-metre drop-off test in seconds), 3) maximum speed (30-metre flying test in seconds), and 4) speed endurance (150-metre endurance test in seconds). In the procedure of the study, pre- and post-tests were taken before and after 2 months of repetition and a new interval training

programme for the repetition training group and the new interval training group. Before the test regarding data collection, all necessary track and field markings were done.

Procedures for administration of tests

Making ensuring a test is objective rather than subjective and that it accurately measures the requirements for the test is crucial. In order to do this, all tests must be precise (created to evaluate an athlete's fitness for the activity in issue), valid (test what they set out to test), repeatable (capable of being repeated consistently), and objective (give a consistent answer regardless of the tester) (Mackenzie, 2005). The following tests were thus employed in this study to evaluate an athlete's progress in anaerobic fitness after training treatments.

Statistical analysis

Pre- and posttest scores were collected from randomly selected new interval training (n = 15) and repetition training (n = 15) groups before and after 8 weeks of training intervention, and the scores were recorded. Both training methods were given for eight consecutive weeks, and attendance was taken throughout the training. Power, fatigue index, anaerobic efficiency, speed endurance, and maximum speed were selected as anaerobic fitness parameters to be tested.

After collecting reliable data through experimental methods such as pretests and posttests of each variable, the researcher analysed and interpreted it. All data was analysed using tables and descriptive statements in SPSS version 23 at an alpha level less than or equal to 0.05. Thus, the collected data were analysed using a paired sample t-test to analyse the pre-test and post-test results of both training methods, and an independent sample t-test was used to analyse the comparisons between the new interval and repetition training groups. Unless this has been done very carefully, misleading conclusions may be drawn, and the whole purpose of doing research may reduce its quality. In addition, based on the analysed and interpreted results and discussion, brief conclusions and finally a recommendation have been obtained.

III. Result and Discussions

Demographic characteristics of participants

Table 1.1: Demographic Characteristics of Participants of NTG and RGT

Group	***N***	***Age***		***Weight***		***Training Experience***	
		Mean	***SD***	***Mean***	***SD***	***Mean***	***SD***
New Interval Training	15	15.93	.884	45.033	6.778	4.27	.884
Repetition training	15	15.93	.961	45.810	6.451	4.20	.862

As shown from the above table, descriptive characteristics of 30 study participants from Tilili Athletics project were found in mean ± SD of age (NTG=15.93±0.884, RTG=15.93±0.961), weight (NTG=45.033±6.778, RTG= 45.810±6.451) and training experience (NTG=4.27±0.884, RTG=4.20±0.862). This indicates the subjects were relatively had the same age, weight and training experience.

Table 3.2: Descriptive Statistics of Anaerobic fitness test variables

Fitness tests	Group			
	NTG		RTG	
	Mean± Std. Deviation		Mean± Std. Deviation	
	PT	POT	PT	POT
400m drop off test	3.784±1.244	3.482±0.682	3.409±1.737	2.675±1.054
150m endurance test	23.905±1.675	22.659±1.445	23.260±2.256	21.6140±2.303
30m flying test	4.4333±0.284	4.139±0.360	4.42±0.358	3.6907±0.486
Power	381.57±108.54	484.08±163.69	385.48±108.93	515.08±173.58
Fatigue index	10.304±4.704	7.080±3.968	9.864±4.166	6.986±2.896

NTG=New interval training group, RTG=Repetition training group, PT=pretest, POT=posttest,

NB: the unit of all scores is second except power and fatigue index (watt)

The above table shows the mean, and standard deviation of pre and posttest scores for the five anaerobic fitness test variables for both training groups (NTG and RTG).

The above table (4) displays the group statistics of the post-test results of anaerobic fitness test variables: 400m drop off test, 150m endurance test, 30m flying test and RAST test for both repetition training group and new interval training group. From the data, we can see that 400m drop off test score of the pre and post-test mean value of new interval training were found to be 3.784±1.244 and 3.482±0.682 second and repetition training group post-test mean value were found to be 3.409±1.737 and 2.675±1.054 second respectively. Therefore, the mean value score of 400m drop off test indicated that, after intervention of new interval training versus repetition training with selected exercise, the subjects performed the given distance and there was difference between the two groups. Yet, we cannot determine here if this difference was statically significant.

In addition, Pre and post-test results of 150m endurance test for both new interval training group and repetition training group was displayed in table 4. As shown in the table the pre and post-test mean value of new interval training group were found to be 23.905±1.675 and 22.659sec±1.445sec and repetition training group post-test mean value were found to be 23.260±2.256 and

21.614sec±2.303sec respectively. Therefore, the mean value score of 150m endurance test indicated that, after exposed to new interval training group versus repetition training there was deference between pre and post and between the two groups.
Despite one can see that there was still a difference, we cannot determine here if this difference was statically significant yet. Similarly, the table above (4) also showed us pre and posttest results of flying 30m test to measure the maximum speed of the athletes for both intervention groups. Thus, the pre and post-test mean value of new interval training group were found to be 4.4333±0.284 and 4.139sec±0.360sec and repetition training group post-test mean value were found to be 4.42±0.358 and 3.6907sec±0.48575sec respectively.
Therefore, the mean value score of flying 30m test indicates that, after intervention repetition versus new interval training with selected exercise, the subjects were performed 30m running at maximum speed and there was deference between pre and post and between the two groups. However, it was difficult to decide whether the difference is statistically significant or not.
Finally, the above descriptive statistics table also includes, power and fatigue index of RAST test of pre and post-test results. The result showed that the mean value score of power and fatigue index for new interval training groups were 381.57±108.54sec pre and 484.076±163.691watt post-test result and 10.304 ±4.7038watt/sec pre and 7.080±3.968 watt/sec post-test results respectively. Moreover, the mean value of both power and fatigue index for repetition-training group were found to be 385.48±108.93 watt pre, 515.077±173.584watt post-test, 9.864±4.166watt/second pre, and 6.986±2.896watt /sec. post-test respectively. We can see that there was still a difference. However, we cannot determine here if this difference was statically significant. Therefore, to identify the statistical significant difference, paired sample t-test and independent sample t test must be applied as follow.

Table 3.3: Paired Samples t-Test Results of NTG and RTG

Anaerobic fitness tests	subjects	Paired Differences					T	DF	P
		MD	SD	SEM	95% CI of the difference				
					Upper	Lower			
400m drop off	NTG PT-POT	.302	.756	.195	-.117	0.721	1.548	14	.144
	RTG PT-POT	.734	.814	.210	.283	1.185	3.493	14	.004
150mendurance	NTG PT-POT	1.246	.670	.173	.8751	1.617	7.205	14	.000
	RTG PT-POT	1.645	.770	.199	1.219	2.072	8.279	14	.000
30m flying	NTG PT-POT	.295	.257	.066	.153	.435	4.446	14	.001
	RTG PT-POT	.729	.461	.119	.474	.984	6.128	14	.000
Power	NTG PT-POT	-102.5	111.46	28.780	-164.23	-40.77	-3.561	14	.003
	RTG PT-POT	-129.6	116.64	30.116	-194.19	-65.02	-4.303	14	.001
Fatigue Index	NTG PT-POT	3.224	2.836	.732	-4.794	-1.654	4.403	14	.001
	RTG PT-POT	2.878	2.986	.771	-4.532	-1.224	3.733	14	.002

Key: - NTG=New interval training group, RTG=Repetition training group, PT= pre-test, POT=post-test, SEM= St. Error mean, MD= mean difference, df= degree of freedom, SD=Standard deviation, CI= Confidence Interval, P= Sig. (2-tailed**)**
NB: the unit of all scores is second except power and fatigue index (watt)
The above table shows the paired sample test of significance differences of the two experimental groups (NTG and RTG) of pre and post-test results. According to the data presented in the table, the pre and post-test result of 400m drop off test showed statistically a significant difference in RTG. The result suggested that RTG significantly improved anaerobic efficiency when measured in 400m drop off test (MD=0.734, SD=0.814, p=0.004) than NTG (MD=0.302 SD=0.756, p=.144). Hence, (P <0.05) Post-test score of 400m drop off test was significantly improved than pre-test scores for the RTG. However, no significant improvement was observed in NTG (p>0.05).
The above table (5) also displays the test of significance differences of the two groups (NTG and RTG) of pre and post-test results of 150m endurance test, 30m flying test, power and fatigue index test. Thus, the pre and post-test result of 150m endurance test for both NTG and RTG showed statistically significant difference (MD=1.246, SD=0.670, p=.000) in NTG and (MD=1.645,SD=0.770, p=0.00) in RTG. Hence, (P<0.05) posttest score was significantly increased than pretest score for both groups. Similarly, the mean value of pre and post-test result of flying 30m test, which was used to measure maximum speed of both NTG and RTG showed statistically significant difference. The results indicated that for NTG (MD=0.295, SD=0.257, p= 0.001) and for RTG (MD=0.729, SD=0.461, p=0.00) is significant at 0.05 level of confidence. The RAST test of power test also showed a significant difference from pre to post-test in both groups (i.e. MD=-102.50, SD=111.46, p=0.003 for NTG and MD=-129.59, SD=116.64, p=0.001 for RTG) which is significant at 0.05 confidence. Hence, (P <0.05) Post power test result was significantly improved than pre-test scores for both training group.

Table 3.4: Independent Sample t-Test of Post- Test Result Measured Between Two Group

Independent Samples Test

Anaerobic fitness test		Levene's Test for EOV	t-test for Equality of Means

		F	Sig.	T	Df	P	MD	SED	95% CI of the Difference	
									Lower	Upper
400m drop off	EVA	5.453	.027	2.489	28	.019	.807	.324	.148	1.470
	EVNA			2.489	23.98	.020	.807	.324	.138	1.475
150m enduranc e	EVA	12.455	.001	1.488	28	.148	1.045	.702	-.394	2.482
	EVNA			1.488	23.54	.150	1.045	.702	-.406	2.495
Power	EVA	.196	.661	-.503	28	.619	-31.00	61.604	-157.19	95.189
	EVNA			-.503	27.90	.619	-31.00	61.604	-157.21	95.208
fatigue index	EVA	2.961	.096	.074	28	.941	0.0940	1.268	-2.504	2.692
	EVNA			.074	25.61	.942	0.0940	1.268	-2.515	2.703
30m flying	EVA	1.170	.289	2.870	28	.008	.448	.156	.128	.767
	EVNA			2.870	25.80	.008	.448	.156	.127	.768

The findings of the present study revealed that there were significance differences before the training and after 8 weeks of new interval training on athlete's speed endurance when assessed in 150m endurance test score by measuring the time taken to cover 150m distance running. The result suggests that NTG significantly improved speed endurance (MD=1.022, SD=0.756, p=.000). Hence, (P <0.05) Post-test value of speed endurance was significantly improved in 150m endurance test score than pre-test values for the NTG.

As showed in the data (table 3.2) the mean values of 150m endurance test score were 14.8340 second in before new interval training, which was improved (reduced) to 13.8120 second after 8 week new interval training, this means the 150m endurance test score in speed endurance of NTG increased by 1.022 second after 8 weeks of new interval training. The increment of the rate of this score was one indicator of the improvement of the athletes' speed endurance. The reason behind this change was new interval training that they were engaged in.

This finding is in line with the finding of Araujo, Gobatto, Marcos, and verelngia (2015) concluded that interval-training method with active recovery activities have been more recommended to promote anaerobic adaptation due to active roll on recovery period that enables the exclusion of elevated intensity. Another researcher which has relationship with the present study Tirkey (2014) also confirm that give an idea of nature of 200 meters sprint which require speeds, as well as speed endurance and might be improved by interval training method.

Another result obtained from the table of NTG revealed that there were significance differences before the training and after 8 weeks of new interval training on athlete's maximum speed when assessed in 30m flying test score by measuring the time taken to cover 30m distance running. The result suggests that NTG significantly improved maximum speed (MD=0.295, SD=0.257, p= 0.001). Hence, (P <0.05) maximum speed of NTG Post-test value was significantly improved in 30m flying test score than pre-test value. As showed in the data (table 3.2), the mean values of 30m flying test score were 4.4333 second in before new interval training, which was improved (reduced) to 4.1387 second after 8 week new interval training, this means the 30m flying test score in maximum speed of NTG increased by 0.295 second after 8 weeks of new interval training.

Furthermore, as we have seen the above paired sample t test (table 5) there were significance differences before the training and after 8 weeks of new interval training on athlete's power when assessed in RAST test of power test score by measuring running based anaerobic sprint test (35m). The result suggests that NTG significantly improved power (MD=-102.50, SD=111.46, p=0.003). Hence, (P <0.05) Post-test scores of athlete's power was significantly improved in RAST power test score than pre-test values for the NTG. As the data (table 4) showed the mean values of RAST power test score were 381.575watt in before new interval training, which was improved to 484.076watt after 8 week new interval training, this means the RAST power test score in power of NTG increased by 102.50 watt after 8 weeks of new interval training. The increment of the rate of this score was one indicator of the improvement of the athletes' power.

IV. CONCLUSION

Based on the result of the study, the following points were stated as a conclusion:

- Implementing new interval training has a significant positive effect on anaerobic fitness variables such as anaerobic efficiency, speed endurance, maximum speed, power, and fatigue index as measured pre- and post-test.
- Implementing repetition training has a significant positive effect on anaerobic fitness variables such as anaerobic efficiency, speed endurance, maximum speed, power, and fatigue index as measured pre- and post-test.
- The repetition training method is better than the new interval training method at improving maximum speed and anaerobic efficiency.
- Repetition training and new interval training methods have no significant differences on the effects of speed endurance, power, and the ability to resist fatigue (fatigue index).

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