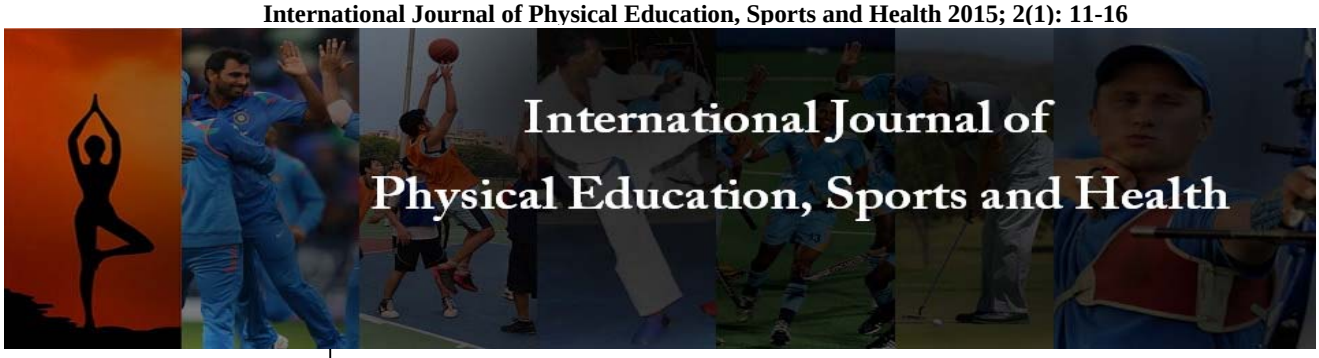

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The effectiveness of circuit training in enhancing muscle endurance among standard five boys in a primary school

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Abstract
The aim of this study is to determine the effectiveness of circuit training in enhancing muscle endurance among standard five boys in a primary school student. This study involved 40 students, which is randomly chosen boys. 20 subjects (n=20) were randomly chosen as the control group whereas the other 20 subjects (n=20) were selected as the experimental group. The intervention programme carried out for the treatment group was shuttle run, sit up and burpee. The intervention programme was carried out for 8 weeks. "Intact sampling" was used, where all the students remain in classes as subjects. The 'independent t-test' on both groups indicated significant difference ($p<0.05$) between mean score of the control group and mean score of the experimental group. This study indicates that intervention programme for 8 weeks improved the muscle endurance of the standard five boy's primary school students at state Petaling Jaya, Selangor.

Keywords: Effectiveness, Circuit Training, Muscle Endurance

1. Introduction
Physical education (PE) is a compulsory subject in primary schools and all pupils must participate in it. Will the syllabus of this subject assist pupils in testing their muscle endurance for 30 minutes? The existing PE subject in schools was unable to improve the pupils' muscle endurance. Apart from that, muscle enhancement trainings are important for pupils to succeed in any sports events as required by the Malaysian Ministry of Education. Hence, the pupils' muscle endurance must be attended to so that they will be able to involve themselves in the sports areas that they prefer.
In Malaysia, a study by Malathi (2003) [22] has researched on the 5 components of physical fitness among form 4 female students which are the cardiovascular endurance, muscular endurance, flexibility, muscular strength and fat composition. Balasubramaniam (2011) [2] has studied about the cardiovascular components for form 4 male students through the circuit training on them. The circuit training employed the quasi experimental method that involved 2 groups namely the control group that did not receive the circuit training and treatment group that received 10-week circuit training. The result of the study revealed that there is positive change towards the group of students that received the 10 weeks of treatment.
Researches on fitness were primarily done in secondary schools, so is a study by Shamsul Kamar (2008) [27] who has studied about the effects of plyometric training towards the muscular strength of football players in secondary school. Therefore, in this research, the researchers plan to study at the primary school level. Researches on primary school pupils were still low in Malaysia, especially those related to circuit training and its relationship with muscular endurance. Thus, the researcher has conducted a research related to the hand muscular endurance among year 5 male primary school pupils through an additional exercise to assist in improving muscular endurance.

1.1. Circuit Training
Circuit training was first introduced in the University of Leeds, England in the 1950s by R. E. Morgan and C. T. Anderson. This exercise contains a series of training battery according to the

requirements of different sports which are determined according to stations. Each person is required to complete the determined activities until the end of a series or circuit.

The number of sets is determined by the trainer based on the achieved objectives. The circuit training is an exercise that involves a number of physical behaviors arranged in a certain sequence. It is done consecutively according to a numbered sequence. The principles of circuit training that must be adhered to are:

1. Specific training for individual fitness level.
2. Activities must be designed to suit the aim and objective of the training.
3. Must involve all body parts and arranged in such a way so that the activities for the same parts are not done consecutively.
4. Correct method and techniques in implementing each activity must be synchronized.

Morgan and Adamson (1961) [23] have provided 3 main characteristics of circuit training. Firstly, circuit training is intended to build muscle and cardiovascular fitness. Secondly, it is using the principle of excess weight and simultaneous circuit training, so that the number of repetitions for the activities is determined thus they will be able to assess the development in the change of behavior time. According to Sheikh (1987) [28], circuit training is a fitness exercise method that intends to increase muscle strength and cardiovascular endurance. To add, the circuit training is one of the training methods that are always used to evaluate physical fitness (Hazeldine, 1992) [16].

According to a study by Kravitz, Mac Lean, Ruby and Leadbetter (1992) [20], circuit training can increase fitness which is related to health and involves aerobic and anaerobic power, hence very suitable to be applied for school pupils. The circuit training can be made as a main instrument in physiological exercise program by trainers who wants to train their teams at primary school level.

According to Foster and Overholt (1994) [11], circuit training in the form of sports skills will increase fitness and excitement for players. It will encourage continuous players' participation. The sequence of challenging sports skill circuit training will encourage players to complete all circuits by employing all skills in a set. Circuit training must be arranged so that all body muscles can be used in a circuit to provide optimum effect.

According to Kravits (1997), circuit training is a training program that was developed by Morgan and Adamson in the year 1953 in the University of Leeds, England. Fleck (2004) [10] stated that this type of training program is appropriate for the short term preparatory phase. Stone (2007) [31] further said that circuit training is more uitable for novice groups who want to be involved in weight lifting based sports training.

1.2. Muscular Endurance

In the year 1961, Sargeant has introduced the muscular endurance test that consists of six different activities and must be completed in 30 minutes. The types of activities introduced are such as push-up, pumping etc. according to this study, when the endurance training for a particular part of the body is heightened to a higher level, the other body parts that did not receive the training will increase by 28%. This situation shows that endurance is not directly related with the maximum strength building. Therefore, the increment of muscle endurance is not necessarily similar with the increment in strength. According to De Vries (1966) [8], muscular endurance is the ability to restrain muscle fatigue during physical activities.

A study by Whitmore (1974) stated that muscular endurance can be measured by a number of ways including maximizing the push-up and pumping activities. Equipment such as Ergograph is used in labs to measure the muscular endurance. According to the study, the researcher will utilize two types of tests, which are the pumping test to assess arm muscle endurance as well as the half squat jump to assess the leg muscle endurance. It is hoped that by employing these two tests, it will provide a better result to compare the muscle endurance between the arm and leg.

Meanwhile, another study was done by Suominen (1977) [32] to find out the effect of metabolism endurance training. This study was also intended to find out the effect of training towards skeletal muscle endurance among males between 57 to 70 years old. It was found that 36 of the subjects acquired effects which were similar to younger males. Through this study, the relationship between muscular endurance, cardio respiratory performance and energy metabolism within the muscle were similar between older and younger males. Barrow and Mc Gee (1979) further added that each individual possesses muscle endurance that is able to execute better movements although the muscles had to withhold strong weight or obstacles.

Torranin, Smith & Byrd (1979) [33] studied on the effects on muscles after being dehydrated by heat due to isometric and isokinetic muscle endurance. Similar exercises such as hand grip, arm curl, bench press and leg press conducted after dehydration have shown decreased performance of muscular endurance. Meanwhile, Gabbard, Kinbyand Patterson (1979) [12] has done a study to determine whether straight arm hold activity can be used as a test to measure children's (between 2 to 6 years old) muscular endurance. The test showed realiable characteristics for children between 4 to 5 years old, but quite hesitating for those 3 years old and below.

Barnes (1980) [3] has studied and analysed the relationship between isokinetic strength and isokinetic endurance. He found that if muscular endurance is defned as a repeated frequency done in training, then there is no relationship between muscular strength and endurance. Barnes' (1980) [3] study has found that the level of muscular strength can be defined as a repeated frequency in a training session. His study analyses the relationship between muscular strength and endurance for the arm and leg. Van Pelt (1983) [35] explained that muscular endurance is tested in high obstacle exercise such as repeated bench press. This effect is not good towards the cardiovascular and respiratory system.

Corbin and Lindsey (1985) [5] stated that muscle force is the ability of a muscle or a group of muscles to perform contraction in order to overcome certain obstacle continuously in a long period of time.

1.3. Research Framework

The researchers have selected the quasi experimental method for this research. The method contains the pretest and posttest to make comparison between the 2 subject groups which are the treatment group and the control group (Gay, 1992) [14]. The treatment group was given circuit training as an additional training to find out the difference between the treatment and control groups. One of the limitations in conducting this research was the difficulty of the researchers to select random samples due to the different timings for the different teaching periods of PE classes. The arrangement of PE lessons in primary school is according to classes and not according to samples.

This study was conducted for 8 weeks. On the first week, the researchers have performed a pretest to collect the data about muscular endurance for both groups. The teaching of PE will commence as planned in the teaching plan but an intensity program will be included for the treatment group. The intervention program will be conducted for 8 weeks in the teaching of PE to find out whether there is any significant difference between the treatment and control groups.

2. Data Analysis

2.1. Descriptive statistic for the Pre Test and Post Test for the Control and Treatment Groups towards Muscle Endurance

Table 1 shows the descriptive findings on the mean scores for the pretest and posttest for the control and treatment groups in terms of the muscle endurance component. The findings are explained only by using mean and standard deviation values.

Table 1: Descriptive Statistic for the Pre Test and Post Test for the Control and Treatment Groups

Component		Control N=20		Treatment N=20	
		Pre Test	Post Test	Pre Test	Post Test
Muscle Endurance	Mean	3.45	3.95	5.45	4.454
	SD	2.012	1.356	13.75	3.432

Based on Table 1, the mean score for the treatment group's pretest in terms of the muscle endurance component is 3.45 with the standard deviation of 2.012 while the mean score foritspost test is 3.95 with the standard deviation of 1.356. The mean score for the treatment group's pre testis 5.45 with the standard deviation of 13.75 while the mean score for its posttest is 4.454 with the standard deviation of 3.43.

2.2. Independent t-Test Analysis towards the Pre Test Scores between the Control and Treatment Groups in terms of Muscle Endurance

Table 2 indicates the mean scores finding for the pretest of both the control and treatment groups. The findings will then be analysed by using the inferential independent t-test analysis to find out whether there is any significant difference between the mean scores of the pretests for both the control and treatment groups.

Table 2: Comparison of Pre Test between the Control and Treatment Groups in terms of the Muscle Endurance

	Group	Mean	Mean Difference	SD	t-value	p-value
Pre Test	Control	3.45		2.012		
			2.00		2.127	0.047
	Treatment	5.45		4.454		

N=40; df= 18; p<0.05

Based on Table 2, it was found that the mean score for the pretest of the control group is 3.45 with the standard deviation of 2.012, while the mean score for the pretest of the treatment group is 5.45 with the standard deviation of 2.00. The independent t-test analysis reveals that the t-value is 2.127 (p<0.05). This shows that there is a significant difference in terms of muscle endurance between the control and treatment groups. It also depicts that both groups have difference with each other.

2.3. Paired t-Test analysis between the Pre Test and Post Test in the Control Group

Table 3 shows the mean score of pretest and posttest in the control group. This finding was then analysed by using paired t-test inferential statistic to find out whether there is a significant difference between the mean scores of pretest and posttest within the control group.

Table 3: Comparison of Pre Test and Post Test for the Control Group

Treatment Group	Mean	Mean Difference	*SD*	*t-value*	*p-value*
Pre Test	3.45		2.92		
		-0.5		-1.648	.116
Post Test	3.95		1.356		

N= 20; df= 18; p>0.05

Based on Table 3, it was found that the mean score for the pretest is 3.45 with the standard deviation of 2.012 while the mean score for the post test is 3.95 with the standard deviation of 1.356. The mean difference is 0.5. Paired t-test analysis on the pre and posttests reveals a t-value of -1.648 (p>0.05). The finding of this analysis shows that there is no significant difference between the pretest and posttest within the control group in terms of muscle endurance.

2.4. Paired t-Test analysis between the Pre Test and Post Test in the Treatment Group

Table 4 shows the mean score of pretest and posttest in the treatment group. This finding was then analysed by using paired t-test inferential statistic to find out whether there is a significant difference between the mean scores of pretest and posttest within the treatment group.

Table 4: Comparison of Pre Test and Post Test for the Treatment Group

Treatment Group	Mean	Mean Difference	*SD*	*t-value*	*p-value*
Pre Test	5.45		4.454		
		-8.3		-13.115	.000
Post Test	13.75		3.432		

N= 20; df= 18; p<0.05

Based on Table 4, it was found that the mean score for the pretest is 5.45 with the standard deviation of 4.454 while the mean score for the post test is 13.75 with the standard deviation of 3.432. The mean difference is -8.3. Paired t-test analysis on the pre and posttests reveals a t-value of -13.115 (p<0.05). The finding of this analysis shows that there is a significant difference between the pretest and posttest within the treatment group in terms of muscle endurance.

2.5. Independent t-Test Analysis towards the Pre Test Scores between the Control and Treatment Groups in terms of Muscle Endurance

Table 5 indicates the mean scores finding for the post test of both the control and treatment groups. The findings will then be analysed by using the inferential independent t-test analysis to find out whether there is any significant difference between the mean scores of the post tests for both the control and treatment groups.

Table 5: Comparison of Post Test between the Control and Treatment Groups towards Muscular Endurance

	Group	Mean	Mean Difference	*SD*	*t-value*	*p-value*
Post Test	Control	3.95		1.356		
			9.8		12.787	.000
	Treatment	13.75		3.432		

N= 40; df= 18; p<0.05

Based on Table 5, it was found that the mean score for the post test of the control group is 3.95 with the standard deviation of 1.356, while the mean score for the post test of the treatment group is 13.75 with the standard deviation of 3.432. The independent t-test analysis reveals that the t-value is 12.787 (p<0.05). This shows that there is a significant difference in terms of muscle endurance between the control and treatment groups.

3. Results and Discussion

The findings of the study shows that the mean score for the post test of the control group is 3.95 with the standard deviation of 1.356, while the mean score for the post test of the treatment group is 13.75 with the standard deviation of 3.432. The mean difference is 9.8. The independent t-test analysis reveals that the t-value is 12.787 (p<0.05), showing that there is a significant difference in terms of muscle endurance between the control and treatment groups.

This proves that the group that has undergone the circuit training intervention program which is the treatment group has acquired increment in the muscle endurance as compared to the control group that did not undergo the intervention program.

3.1. Research Question 1

3.1.1. Is there any significant difference towards the muscle endurance between the mean scores of the pretest and posttest within the control group?

The control group has undergone the PE classes as usual for 8 weeks and did not undergo the circuit training intervention program. According to Table 3, the mean score for the pretest is 3.45 with the standard deviation of 2.012 while the mean score for the post test is 3.95 with the standard deviation of 1.356. The mean difference is 0.5. Paired t-test analysis on the pre and posttests reveals a t-value of -1.648 (p>0.05), and not significant (p =116 >0.05).

The insignificant t-test is probably due to the reason that the pupils possess less interest in the PE class and they only undergo normal PE lessons without any fitness training such as the circuit training.

3.2. Research Question 2

3.2.1. Is there any significant difference towards the muscle endurance between the mean scores of the pretest and posttest within the treatment group?

The treatment group has undergone a normal PE classes once a week for 30 minutes but added with a set on circuit training intervention program for 3 minutes, which was included in their lesson. The findings show that the level of muscle endurance of the primary school pupils has experienced significant change within the treatment group after they have undergone the intervention prpgram for 8 weeks continuously without interruptions.

Table 4 shows the mean score for the pretest is 5.45 with the standard deviation of 4.454 while the mean score for the post test is 13.75 with the standard deviation of 3.432. The mean difference is -8.3. Paired t-test analysis on the pre and posttests reveals a t-value of -13.115 and significant (p = 0.000 < 0.05).

The findings denote that there is a significant difference between the pretest and posttest within the treatment group towards the muscle endurance component. It can be concluded here, that the addition of the circuit training intervention program for 3 minutes included in the PE lessons for 8 weeks to the treatment group is effective in increasing the muscle endurance of primary school pupils.

The finding of this study is in line with those studies by Vanitha (2007) [34]; Arjunan (2006) [1]; Singh (2004) [30]; Werner & Durham (1988) [36]; Dragevik *et al*. (1987) [9] where circuit training intervention program in the duration of 10 weeks for twice a week has shown significant difference in terms of muscle endurance within the treatment group. A once-a-week 80 minutes circuit training intervention program for 10 weeks has also shown significant difference for muscle endurance (Malathi (2003) [22]. According to Hamlin *et al*. (2002) [15]; Baquet, *et al*. (2001) [4]; Ignico & Mahon (1995) [19], the effectiveness of consistent intervention program has proven escalation towards physical fitness among school pupils. Meanwhile, Ignico, *et al*. (2006) [18]; Derri *et al*. (2004) [7]; Hamlin, *et al*. (2002) [15]; Hetrik, *et al*. (2002) [17]; Shepherd & Lavalee (1996) [29]; Mahan & Vaccaro (1994) [21]; Werner & Durham (1988) [36] have concluded that the escalation of physiology adaptation process in bodies can only be achieved if the implementation of intervention program is prepared in accordance to the GAS theory.

However, the researchers in this study has conducted the circuit training intervention program in only 8 weeks and the results of the study showed that there is a significant difference between the pretest and posttest within the treatment group towards the muscle endurance fitness. The exercise that has been done once a week for 30 minutes for a time frame of 8 continuous weeks was able to increase the muscular endurance of year 5 primary school pupils. Apart from that, the circuit training intervention program for 3 minutes with a progressive training intensity, which is from low intensity to high intensity and done in a long time frame which is for 8 weeks, has provided enough stress towards the muscles that the physiological adaptation process was able to happen as suggested by the researchers such as Wilmore, 1997; Ignico & Mahon, 1995 [19]; Rowland, 1985 [25].

To conclude, apart from the 3-minutes circuit training intervention program, the increment of muscle endurance in the treatment group is also may be due to other factors such as active involvement of students in sports co-curriculum activities and games in the school.

3.3. Research Question 3

3.3.1. Is there any significant difference for the mean score of the posttest towards muscular endurance between the control and the treatment groups?

All subjects from the control and treatment groups have gone through the pretest on the first week and followed by PE classes for 8 weeks. The PE activities for both groups were similar but the treatment group was added with a set of intervention program which was the circuit training for 3 minutes.

Table 5 shows that the mean score of the post test for the control group was at 3.95 with a standard deviation of 1.356. While the mean score of the post test for the treatment group was at 13.75 and standard deviation of 4.432. The mean difference was 9.8. Meanwhile, the result of the independent t-

test shows that there was a significant increase in the treatment group as compared to the control group with the t = 12.787 (p=000< 0.05).The intervention group that has gone through the PE lesson once a week for 30 minutes with additional of 3 minutes of circuit training for 8 weeks has shown an increase in the muscular endurance as compared to the control group which was without intervention.

The treatment group that has gone through the circuit training intervention program has shown significant difference in the muscular endurance. According to the GAS theory, physiology adaptation happens with an exercise included in an intervention program. The usage of intervention program has shown significant effects in increasing health based physical fitness among school pupils (Hamlin, *et al*., 2002; Baquet, *et al*., 2001; Ignico & Mahon, 1995) [15, 4, 19]. Studies by Wilmore & Costil (1999) as well as Paabo & Karman (1981) [24] have shown that aerobic activity for 15 to 60 minutes for 3 to 5 days with the intensity of 50% to 85% is vital in a physical training program to increase and maintain health related physical fitness. Another study by Ericson & Koch in the year 1973 has reported the result of research on children aged between 11 to 13 years old who have gone through training for 60 minutes, 3 times per week for 16 weeks that showed 16% increment in VO2max.

The treatment group has gone through a set of intervention program for 3 minutes once a week for 8 weeks. The intervention program has increased the muscular endurance of the treatment group as compared to the control group. In this research, the researchers have planned the circuit training activities within the treatment group beginning with low intensity training for 2 weeks. After that, the researchers have conducted tarining with moderate intensity for 3 weeks and lastly with high intensity training for another 3 weeks.

4. Conclusion

This research is intended to find out the extent to which the effectiveness of the circuit training intervention program included in PE subject can increase muscular endurance among year 5 pupils in a primary school in the district of Petaling Jaya, Selangor. The result of the research showed that the circuit training for 8 weeks was able to increase muscular endurance among primary school pupils.

This implies that when an additional method was adjusted into a teaching session like the additional exercise, an intended effect will happen. Therefore, the circuit training exercise must be instilled in the PE teaching sessions in all primary schools to enhance the primary school pupils' muscular endurance. Also, the circuit training exercise does not involve any usage of equipment, not dangerous, and less risky for injuries. In terms of time usage, this exercise can only be implemented in the duration of 3 minutes only. Hence, the circuit training can be included in the syllabus of primary school PE as it can provide benefits for the primary school pupils.

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