

The Effect of Unilateral and Bilateral Training Circuit with Ladder Drill and Plyometric Cone on Speed, Agility, Reaction and Balance of Elementary School Students in Indonesia

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Abstract The purpose of this study was to examine and analyze the effects of using unilateral and bilateral circuit training with ladder drills and plyometric cones on the speed, agility, reaction, and balance abilities of elementary school students. The subjects of this study were 28 students in grade 5 of SDN Bawakaraeng II Makassar City, male, aged 10–11 years. The type of research used is quasi-experimental research with a quantitative approach. The results of ordinal pairing were divided into 4 groups. This study found that after the training, students who received the training of unilateral and bilateral circuit ladder drills showed significantly increased on agility by 3.1 seconds and 2.4 seconds respectively. The balance also showed substantially rising by 8.9 and 6.6 seconds, with p value <0.005. For groups with unilateral and bilateral plyometric cones showed that after the training there was a remarkable increase in agility by 3.7 and 2.9 seconds respectively, with p value <0.005. In addition, balance also showed a significant improvement by 10 and 7.1 seconds with p-value <0.005. To conclude, this study found that unilateral and bilateral circuit training with ladder drills and plyometric cones significantly increased agility and balance abilities on children.

Keywords Training Circuit, Plyometric Cone, Ladder Drill, Elementary School

1. Introduction

The main problem for elementary school students, aged range of 10-11 years in this modern era is the inactive lifestyle, they tend to spend their leisure time in playing games, watching YouTube, playing computers and watching TV. This lifestyle leads them to neglect physical activity which should be a period of development of their physical and bio-motor abilities [1].

Studies have found that daily physical activity in children has decreased by an average of 7% per year [2]. In addition, the Indonesian National Basic Health Research Data (2018) found the prevalence of obesity in children under five was increasingly, that reported in 2007, 2010, 2013 and 2018, respectively 12.2%, 14.0%, 11.9% and 15.8% [3]. In encouraging children to do physical activity, a play system is needed that makes them happy

and excited to do it. One method of fun and interesting activity for children is *Circuit Training* [4]. In addition, circuit training approved can reduce body mass index (BMI) in obese children [5]. Circuit training is an interval physical exercise program, which is a combination of strengthening exercises and aerobic exercise, beneficial for the components of physical condition. This type of exercise is circuit so that it is not boring [6] whose form of exercise is arranged in a circle and consists of several posts [7].

In this COVID-19 pandemic situation, based on government recommendations, most people are required to do their activities at home. For school-age children, they are required to do online learning which requires gadgets almost every day. Because this causes addiction to the device itself, not only for studying but also for other activities such as games, watching and so on. This addiction can cause teenagers to be less mobile (hypokinetic) so that there is an increased risk of suffering from degenerative diseases in the future [8] [9].

In this new normal period, researchers think that this is the right time for efforts to increase students' physical abilities to have better body resistance. For this reason, researchers are trying to create a system or training method that is interesting and can be packaged at the age of those who are 10-11 years old. The researcher made the decision to make a physical activity in the form of a circuit where the circuit used was a ladder drill circuit and a Plyometric Cone circuit. The choice of the two Circuit methods was of course with observations by researchers where the ladder drill and Plyometric Cone methods may be common for sports players, but in the scope of education at the school, it is a new thing for students. Therefore, students will be interested in playing and physical activities.

Based on the background description above, this study aims to analyse the effect of unilateral circuit training, bilateral circuit training with ladder drills and plyometric cones on the speed, agility, reaction, and balance abilities of elementary school students.

2. Methods

2.1. Research Design

This is quasi-experimental research with a quantitative approach. The research design uses a factorial design which is a modification of the true experimental design.

2.2. Population and Samples

The population in this study were male students in grade 5 in SDN Bawakaraeng II Makassar City (Elementary school), for a total 30 students with an age range of 10-11 years. This population is limited to only male students based on the consideration that they have the same characteristics in terms of gender and age.

The sampling technique in this study used a proportional random sampling technique. So that the sample taken can be said to be representative, in this study it was determined using the Slovin formula, with error rate used was 5% or 0.05. The total number of students who participated was 28 boys and 2 students did not participate because they were sick.

2.3. Variables

Speed is the ability to move quickly. In this study, speed ability will be measured using a 30 m sprint test. The tool used to calculate speed is a stop watch in seconds. Agility is sports movements that are able to use muscles to perform physical performance change direction rapidly. In this study, to determine the ability of agility measured by a side step tool with units of seconds. Reaction is movements made by the body to respond as quickly as possible after receiving a response or event at a time and to determine the ability of the reaction will be measured using a whole-body reaction in seconds. Balance is sport performance capable of maintaining balance and to determine the balance is measured using a balance beam with units of seconds.

2.4. Data Collection Procedure

This research was conducted in October-November 2020, at Makassar State University. The places used include: Gor Basket, Makassar State University and Makassar State University Sport Science, as a place to carry out data collection tests, both pre-test and post-test including speed, agility, reaction, and balance.

The sample grouping technique uses the ordinal pairing technique, samples were grouped by ordinal pairing (Table 1). Ordinal pairing is one of the sample grouping events with a ranking system. The purpose of using ordinal pairing is to equalize the ability of the sample in each group. Based on the ordinal pairing technique, the samples in this study will be grouped as follows: Group 1 Circuit Unilateral Ladder Drill (7 students), Group 2 Circuit Bilateral Ladder Drill (7 students), Group 3 Circuit Unilateral Plyometric Cone (7 students), Group 4 Circuit Bilateral Plyometric Cone (7 students). How to do ordinal pairing is as follows:

Table 1. Ordinal Pairing Technique

Group 1	Group 2	Group 3	Group 4
<i>Circuit Unilateral Ladder Drill</i>	<i>Circuit Bilateral Ladder Drill</i>	<i>Plyometric Cone Unilateral Circuit</i>	<i>Plyometric Cone Bilateral Circuit</i>
1	2	3	4
8	7	6	5
9	10	11	12
16	15	14	13
17	18	19	20
24	23	22	21
28	27	26	25

Source: Primary Data, 2020

2.4.1. Pre-test

Perform a maximum repetition pre-test which includes: (1). Circuit Unilateral Ladder Drill, (2). Circuit Unilateral Plyometric Cone, (3). Circuit Bilateral Ladder Drill, (4). Circuit Bilateral Plyometric Cone, the results of which are used as considerations in determining the training program for the four sample groups. The training load used in this treatment is based on how long it takes to do a circuit exercise, with a frequency of 3 times per week for 6 weeks.

2.4.2. Experiments

Before carrying out the exercise, the students received a body temperature check, should washing hands or using hand sanitizer, due to this research was conducted in Covid-19 pandemic.

Group 1 and 2

Circuit Exercise Unilateral Ladder Drills; the way to carry out the exercise is to do a series of exercises from post 1 to post 6 using the ladder drill tool. Post 1 single leg jump, post 2 single leg Slaloms, post 3 lateral side, post 4 single leg Traveling, post 5 single leg two forward and one back, post 6 single leg 90 degree. While, Bilateral Ladder Drill Circuit Exercise; the same approach with unilateral but with students use double or two legs.

For both group; in Post 1, the sample performs leg jump through a ladder drill with a length of 520 cm and a width of 50 cm, the distance between the blades is 50 cm, and the number of blades was 15. After that, rest for 2 minutes before moving on to the next post. Repeated until to six posts. The sample performs pulse control to see the results of the exercise program. After that, the sample took a break for 12 minutes.

Group 3 and 4

Plyometric Cone Unilateral Circuit Exercise; the way to carry out the exercise is to do a series of exercises from

post 1 to post 6 using some cones tool. Post 1 single leg jump, post 2 single leg Slaloms, post 3 lateral side, post 4 single leg Traveling, post 5 single leg two forward and one back, post 6 single leg 90 degree. While, Plyometric Cone Bilateral Circuit Exercise; the same approach with unilateral but students used double or two legs. In details, in Post 1, the sample performs leg jump through a cone with a height of 20 cm, a distance between cones of 60 cm, and the number of cones of 15 pieces. After that, rest for 2 minutes before moving on to the next post. It was repeted until six posts. After that, the sample rested for 12 minutes.

2.4.3. Post-test

The end of the treatment for 6 weeks was followed by the implementation of a post test which included a test speed, agility, reaction and balance.

2.5. Data Analysis

Data analysis was carried out in several processes including: Normality test aims to ensure that the data obtained are symmetrically or normally distributed. Normality test using chi-square, kolmogorof-smirnov, and shapiro-wiks. The homogeneity test aims to ensure that the variance of each group is the same or similar, so that comparisons can be made fairly. In addition, the paired T-Test was used to see the difference in results after and before the experiment was carried out. Data analysis using SPSS.20 software program with significance p-value <0.05

2.6. Research Ethics

An informed consent was signed by all the students and parents or guardians before participating in this study. This study received a research ethical permit from Makassar City Government No.070/2403-II/BKBP/XII/2020.

3. Results

Table 2 shows the differences of speed, agility, reaction and balance before and after the training with the circuit unilateral and bilateral using ladder drill. The mean trend of the speed of children decreased by 0.16, and 0.03 seconds after the training respectively on group 1 and 2. Moreover, it showed that after the training in both group, there were remarkable increased on agility by 3,1 seconds in group 1 and 2,4 seconds in group 2 with p value <0.005. In, addition for balance also showed a significant risen by

8,9 and 6,6 seconds respectively, with p value <0.005.

Table 3 shows the differences of speed, agility, reaction and balance before and after the training with the circuit unilateral and bilateral using plyometric cone. The mean trend of the speed of children decreased by 0.64, and 0.12 seconds after the training respectively on group 3 and 4. Moreover, it showed that after the training in both group, there were remarkable increased on agility by 3,7 seconds in group 3 and 2,9 seconds in group 4 with p value <0.005. The balance also showed significant improvement by 10 and 7,1 seconds respectively, with p value <0.005.

Table 2. Differences in speed, agility, reaction and balance before and after training in group 1 and 2

Variable	Group 1					Group 2			
	<i>Circuit Unilateral Ladder Drill</i>					<i>Circuit Bilateral Ladder Drill</i>			
		<i>Pre</i>	<i>post</i>	<i>Difference</i>	<i>p-value</i>	<i>Pre</i>	<i>post</i>	<i>Difference</i>	<i>p-value</i>
Speed	Mean	6,69	6,53	-0,16	0,064	6,43	6,40	-0,03	0,058
	SD	±0,13	±0,18	±0,09		±0,31	±0,33	±0,03	
Agility	Mean	13,6	16,7	3,1	0,003*	14,0	16,4	2,4	0,001*
	SD	±1,71	±2,69	±1,67		±1,83	±1,98	±0,97	
Reaction	Mean	0,384	0,289	-0,095	0,054	0,360	0,285	-0,074	0,054
	SD	±0,02	±0,01	±0,02		±0,04	±0,01	±0,04	
Balance	Mean	14,4	23,3	8,9	0,001*	15,6	22,1	6,6	0,001*
	SD	±3,10	±3,35	±2,73		±2,94	±2,97	±2,64	

Source: Primary Data, 2020

Table 3. Differences in speed, agility, reaction and balance before and after training in group 3 and 4

Variable	Group 3					Group 4			
	<i>Circuit Unilateral Plyometric Cone</i>					<i>Circuit Bilateral Plyometric Cone</i>			
		<i>Pre</i>	<i>post</i>	<i>Difference</i>	<i>P-value</i>	<i>Pre</i>	<i>post</i>	<i>Difference</i>	<i>P-value</i>
Speed	Mean	6,99	6,35	-0,64	0,071	6,74	6,62	-0,12	0,063
	SD	±0,29	±0,30	±0,46		±0,14	±0,18	±0,07	
Agility	Mean	12,9	16,6	3,7	0,001*	13,4	16,3	2,9	0,021*
	SD	±1,34	±2,07	±1,25		±1,72	±1,80	±1,34	
Reaction	Mean	0,401	0,303	-0,099	0,085	0,371	0,284	-0,087	0,075
	SD	±0,02	±0,01	±0,01		±0,01	±0,01	±0,02	
Balance	Mean	14,3	24,3	10,0	0,001*	15,9	23,0	7,1	0,001*
	SD	±3,45	±2,81	±4,04		±2,61	±3,51	±3,02	

Source: Primary Data, 2020

4. Discussion

Researchers have an understanding that using circuits will show a variety of exercise because they can combine all components of physical fitness in one form of exercise. Circuit training is the best way to increase mobility, strength and stamina of children and adolescents [6]. This is in accordance with the results obtained by this study that the unilateral circuit ladder drill and plyometric cone can improve on the balance and agility of children. We know that balance has an important role in several daily activities such as sitting, standing and walking and is an important factor for improving performance, especially for presenting skills in complex movements [10]. With the ability to balance, it is hoped that early childhood can do activities freely without getting injured.

Ladder Drill is a popular piece of equipment for speed, coordination, balance, and agility training for people of different age groups, sports and genders [11]. There was a significant increase in reaction ability, agility and speed, according to research conducted by Robert, et.al on applied dexterity ladder exercises to elementary school students. In addition, Robert's study mentioned there was a relationship between agility and postural stability. Ladder Drill allows the sample in the study to move quickly and move from one box to another. The ability to move in Ladder Drill movement in each box is the ability of reaction speed [12]. Balance ability has increased because when doing exercises or moving activities on agility ladders or ladder drill, muscles contract flexibility following joint movements which will make it easier to perform movements that require balance. The movement through the stairs dynamically and quickly makes the muscles accustomed to making movements and holding body weight to remain standing in a balanced condition [13].

Furthermore, plyometric is an exercise method that includes jumping by utilizing the muscle stretching cycle, which is about the muscle lengthening and shortening cycle or what is commonly called the stretch shorten cycle [14]. Plyometric method has become a general election by trainers in an effort to improve biomotor abilities. This is because the result or impact of the exercise has a very large impact on increasing lower extremity biomotor abilities, especially biomotors that require explosive power or dynamic motion. One of the studies on the Plyometric method conducted by Vaczi, et.al concluded that plyometric exercises consisting of high-impact unilateral and bilateral exercises lead to substantial increases in lower extremity strength [15]. More specifically, they found that rapid movement in motion activities such as body acceleration and deceleration, change of direction, and jumps was frequent and that high levels of dynamic muscle performance were required at all levels of training status [15]. Plyometric exercises have been applied in many studies, and there is general

agreement that they improve sport-specific skills such as agility, run time and acceleration, as well as vertical jump performance [14].

Circuit Plyometric Unilateral Training is also able to improve balance and agility abilities. This is because when doing jumping movements and changing directions using one leg, the muscles contract flexibility in the jumping motion and hold the body in balance following the joint movements which will make it easier to perform movements that require balance [16]. In this case the muscles play a role in strengthening the position and movement of the body in a balanced position. In accordance with the rules of balance biomotor ability which contains the ability to maintain or control the nervous system so that it can work efficiently. Balance is the ability to react to any changes in body position, so that the body is stable [17]. By having a good balance, it is hoped that children will find it easier to control the body to move. We know that the stability of the spine when supporting the body in moving or standing depends not only on muscle strength, but also on appropriate sensory input that alerts the central nervous system to the interaction between the body and the surrounding environment in order to provide constant feedback and allow movement improvement [18].

In a study conducted using bilateral method using circuit plyometrics, it was able to improve the ability of the lower extremities. The same thing was also found when research conducted by Thomas, et al, which states that Plyometric method has consistently been shown to increase the ability of muscle strength and explosive power, especially in an effort to produce explosive movements from trained muscles. This explosive movement increases the results of this exercise which makes the agility also experience a significant increase before doing the treatment and after doing the treatment. This also adds that plyometric exercises have been applied in many studies, and there is general agreement that they improve sport-specific skills such as agility, run time and acceleration, and vertical jump performance [14].

The development of exercise using one-legged jumps or Unilateral Training is better in an effort to improve biomotor abilities, speed, balance and dynamic motion of the lower extremities than the two-legged or bilateral training method. This is relevant to the research conducted by Kusnanik, et al. [19] on one-leg and two-leg exercises showing a more effective increase using one leg, although both have an equally significant increase [20]. One-leg and two-legged exercise had an effect on increasing the speed and explosive power of the players in this study. This is also supported by previous research that exercise using one leg and two legs is effective for increasing strength and power for both men and women [21].

The concept of ground reaction force and ground contact time which is related to the research conducted by the researcher. Plyometric and Ladder Drill training

models that are mostly done by some people are explosive or fast. Exercises that increase explosive movements are exercises that have a high ground reaction force model and fast ground contact time. Plyometric unilateral exercises tend to take the form of quick one-step movements such as hopping [22].

4.1. Research Limitations

Some of the limitations of this study first, the sample focused on fifth grade elementary school students who have an age range of 10-11 years and only on male gender. Thus, these results of this study cannot represent all gender. Second, the number of samples was only 28 students, that might insufficient to describe the actual situation. Third, in the training process most of the sample still tends to play activities at rest between sets. This results in students experiencing fatigue when they continue to the next exercise.

5. Conclusion

Based on the results of research and discussion, several conclusions can be drawn as follows: 1). There were significant effects of circuit unilateral and bilateral ladder drill and plyometric cone on the agility and balance abilities of children. 2). For speed and reaction showed slightly decreased in all groups.

6. Recommendation

Based on the results of the research that has been done, it is recommended as follows: 1). For schools; in schools should use the exercise method using circuit unilateral and bilateral ladder drill and plyometric cone especially children with an age range of 10-11 years. 2). For researchers; in future research, it is recommended to take more samples, this aims for better data accuracy in the research, and to conduct continuous research, this is in order to determine and assess any changes in sample behavior from time to time. In addition, it is recommended that there are additional variables that may also affect many things in this study.

Conflicts of Interest

The author(s) declared no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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