

## **EFFECT OF CIRCUIT TRAINING ON CARDIO-RESPIRATORY ENDURANCE AMONG ADOLESCENTS**

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### **Abstract**

In the contemporary age, an inactive lifestyle is a burning issue. In the context of Pakistan, majority of the adolescents are victims of sedentary lifestyles leading to various chronic problems like cardio-respiratory diseases. In this regard, regular training is considered a medicine and cure to restrict chronic problems. This study focuses on how adolescents' cardio-respiratory endurance is affected by circuit training. This study comprised an experimental, randomized controlled trial and pre/post-intervention study design. The intervention was conducted at the Government College of Management Sciences in Haripur Khyber Pakhtunkhwa, Pakistan. Twenty-four participants were randomly divided into the experimental group (n=12) and the control group (n=12). Before starting the intervention, a pre-test was conducted and then the experimental group was engaged in circuit training intervention whereas the control group was not engaged in intervention. At the end of the intervention, a post-test was conducted. The change in cardio-respiratory endurance for 16–19-year-old participants differed significantly between the experimental group (Heart Rate  $8.083 \pm 3.423$ , Respiratory Rate  $2.750 \pm 1.357$ ) and control group (Heart Rate  $.667 \pm 2.309$ , Respiratory Rate  $-.333 \pm 1.371$ ) ( $p > 0.05$ ) in favor of the experimental group. Circuit training intervention is effective in increasing cardio-respiratory endurance among adolescents.

**Keywords:** Circuit Training; Cardio-Respiratory Diseases; Adolescents; Exercise.

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### **Introduction**

Circuit with the complete training activities are conducted, performed, and executed one after the other training. Moreover, exercises are conducted using a circuit training strategy with little to no break

between sets. Nevertheless, it depends on the kind of circuit being used. Circuit training may be a full-body workout, but to benefit from it (and there are a lot of benefits), it must include both strength and aerobic exercises

(Butcher et al., 2015). One can complete the exercises with the proper level of intensity, in this regard circuit training can be an efficient daily workout approach for losing weight. Workouts with too much weight or resistance can leave you exhausted in under 30 minutes and start to grow muscle at such a rapid rate that rest days may be necessary to fully recover between sessions (Kerksick et al., 2017). On the other hand, Circuit training, a type of cardio exercise that primarily targets the lower body, may use the majority of the body's muscles, significantly increasing oxygen consumption (Feito et al., 2018). Weight loss benefits from any sort of exercise that increases energy expenditure and oxygen demand (Atakan et al., 2021). One of the key elements of physical fitness is cardio-respiratory fitness, often known as cardio, cardio endurance, aerobic fitness, or aerobic capacity. Cardio-respiratory fitness is the state of the respiratory and circulatory systems during activity or work to guarantee the working muscles receive enough oxygen for the productivity of energy (Jourkes et al., 2011). Until the circuit is finished, circuit training might be done at different stations, or it could be repeated with different exercises (Baye, 2019). There are several techniques to develop a circuit including body weight, weight, and dynamic workouts.

Endurance is widely used in sports science, it indicates an athlete's ability to maintain a long workout for minutes, hours, or even days (Olsen et al., 2005). The capacity to persevere through a difficult or unpleasant procedure or event without giving up. The ability to continue an activity for a prolonged duration is also known as endurance or aerobic capacity (Cutsem et al., 2017).

A person's ability to push himself and keep moving for a long time, as well as their resistance to, ability to recover from, and immunity from stress, wounds, or tiredness, are all instances of endurance (also related to sufferance, resilience, constitution, fortitude, and hardiness) (Khanum et al., 2005). Also, endurance is the capacity to keep going despite challenges, exert yourself continuously, and get back up even when you want to give up. Success is determined by one's capacity to endure in the face of challenges and exhaustion. The capacity to withstand muscular exhaustion best represents muscle endurance, indicating how long a particular type of contraction can last. It is often assessed in terms of repetition. Endurance circulation and respiratory systems need to provide muscle energy to support continuous physical training/exercise (Elmagd, 2016). Endurance terms can be

used interchangeably with aerobic fitness (Dasso, 2019). Aerobic means "with oxygen" and oxygen helps supply the necessary energy for the body during aerobic exercise (Deng et al., 2021). Tests on cardiorespiratory endurance monitor how well the heart, lungs, and muscles work during moderate to strenuous activity (Raghuveer et al., 2020). By increasing cardiorespiratory endurance, a person may be able to continue exercising for a longer time (Lee et al., 2010). This improves the heart's and the lungs' ability to absorb oxygen. Cardiorespiratory endurance enhances a person's overall health (Myers et al., 2015). Moreover, the heart and lungs can utilize oxygen more effectively and may work longer without feeling fatigued. People may improve their cardiorespiratory endurance by exercising often (Gerber et al., 2019). Endurance training could be helpful and effective in developing as well as improving the energy production system for maximum output.

Age, sex, health conditions, and genetics could affect cardiorespiratory fitness. Genetic variables account for up to 40% of the variance in the degree of cardiorespiratory fitness (Gutin et al., 2005). Objectively assessed physical activity and cardiorespiratory fitness are positively

correlated in children and adolescents (Andersen et al., 2006). High levels of physical activity and cardiorespiratory fitness are associated with lower all-cause and cardiovascular mortality (Lee et al., 2011). Moreover, regular exercise slows the progression of chronic diseases including cancer, diabetes, stroke, and hypertension.

Adolescent age is considered the rapid development of the human body. Children reach adolescence when they achieve 50% of their adult body weight, go through puberty, become sexually mature, and undergo a remarkable change in their brains. While physical fitness has a direct impact on one's health, it serves as the cornerstone of healthy adulthood (Son & Kim, 2012). Exercise may help maintain a healthy weight, strengthen bones and muscles, boost the capacity to do everyday chores, and enhance cognitive health (McPhee et al., 2016). People who spend less time sitting and exercising at any intensity between moderate and intense have considerable health benefits (Piercy et al., 2018). Moreover, children and adolescents who engage in appropriate physical exercise benefit from increased strength, balance, and body composition. Numerous industrialized nations have nationwide initiatives to motivate children to improve their physical

fitness, such as Trimming 130 in Germany, and EUROFIT in Europe. To assess students' athletic ability, fitness-related health metrics were first created in Korea, in 2009 (aerobic endurance, muscular endurance, flexibility, muscular strength, and bodily fat). The Physical Activity Promotion System (PAPS) is used to continuously manage levels of augmentation in physical activity and fitness among middle, elementary, and high school freshmen. It is done by conducting a systematic assessment of the student's physical fitness and recommending to them healthy physical activity through their parents and teachers. Stepping, running, and walking are all part of a cardiorespiratory endurance test, and the results are graded according to five levels of heart function using heart rate (Kim, 2011). Amongst other components of fitness, cardiorespiratory endurance has many benefits as it helps in prolonging life and strengthening the heart, lungs, and blood arteries all work together to provide oxygen to muscles (McArdle et al., 2010). Results indicated that there is a positive link between a high level of aerobic activity and a high rate of longevity (Hillman et al., 2008). Aerobic exercise has a positive effect on the elders' development (Pascoe et al., 2014). Low blood pressure, low LDL (low-density lipoprotein), and high HDL

(high-density lipoprotein) levels are characteristics of individuals with cardiovascular fitness (Mathieu et al., 2010). Additionally, those who regularly engage in cardiovascular exercise programs have lower resting pulses, which calms them down when at rest (Ankad et al., 2011). To increase the degree of aerobic endurance in the 16–19-year-old (adolescent) age group, more experimental research was needed. The researchers examined the circuit training's effects on adolescents' cardiorespiratory endurance.

### **Materials and Methods**

The purpose of this study is to look at how adolescents' cardio-respiratory endurance is affected by circuit training. After getting ethical approval from The Government College of Management Sciences, Haripur male adolescents aged 16–19, who were studying at the Government College of Management Sciences Haripur, in the city of Haripur, province of Khyber Pakhtunkhwa were selected for the current study. In this context, the researcher selected 24 students randomly and categorized them based on inclusion criteria into an experimental group (EG n=12) and a control group (CG n=12). The participants of the experimental group were engaged in a circuit training protocol (five days a week for twelve

weeks). Four-minute warm-up leading to the Training Protocol and a 4-minute cool down after the protocol were among the important considerations of the intervention.

### Statistical Analysis and Results

An inferential statistical tool (Paired Sample T-test) was used to assess the Effect

of Circuit Training on cardio-respiratory endurance among adolescents between two groups (experimental and control). The level of significance was fixed at a 0.05 level of confidence for all cases. The statistical operation was done using SPSS Software.

### Results

Table 1. Circuit Training schedule for 12-weeks

Stage	Circuit Drills	Duration	Rest intervals	Sets
1	Calf raises	30 Seconds	30 seconds	2 sets (Week 1-6)
	Single-leg standing calf raises	30 Seconds		3 sets (Week 7-12)
2	Static lunges	30 Seconds	30 seconds	2 sets (Week 1-6)
	Reverse lunge with knee drive	30 Seconds		3 sets (Week 7-12)
3	Push-ups with steps out	30 Seconds	30 seconds	2 sets (Week 1-6)
	Bent knee push-up	30 Seconds		3 sets (Week 7-12)
4	Double pulse squats	30 Seconds	30 seconds	2 sets (Week 1-6)
	Squat jumps	30 Seconds		3 sets (Week 7-12)
5	Bench dips	30 Seconds	30 seconds	2 sets (Week 1-6)
	Triceps push-ups on knees	30 Seconds		3 sets (Week 7-12)
6	Abdominal crunches	30 Seconds	30 seconds	2 sets (Week 1-6)
	Front plank reach out	30 Seconds		2 sets (Week 7-12)

Table 2. Paired sample T-test showing the difference between Pre and Post-test Heart Rate (Experimental and Control Group)

Name of Variable	Group	Pre-test score (Mean ± SD)	Post-test score (Mean ± SD)	Pre- and Post-test score differences (Mean ± SD)	t	Sig. (2-tailed)
Heart Rate	Experimental	94.83±7.158	86.75±6.166	8.083±3.423	8.179	.000
	Control	94.50±6.289	93.83±5.132	.667±2.309	1.000	.339

$P < 0.05$ ,  $SD = \text{Standard Deviation}$

Table 2 showed a significant difference in the Heart Rate of participants of the experimental group which points towards a constructive effect of circuit training on the heart rate of participants. In the pre-test, the

heart rate (mean±SD) was 94.83±7.158 and at the end of the 12-week circuit training intervention heart rate (mean±SD) was 86.75±6.166 t-value of 8.179 and a p-value of .000 less than the significant alpha value of

0.05. The reason behind the reduction in Heart Rate was regular circuit training. The results clearly showed that regular circuit training can reduce the heart rate among adolescents. Also, the insignificant effect on the Resting Heart Rate of participants in the control group points towards a negative effect of not participating in any type of exercise.

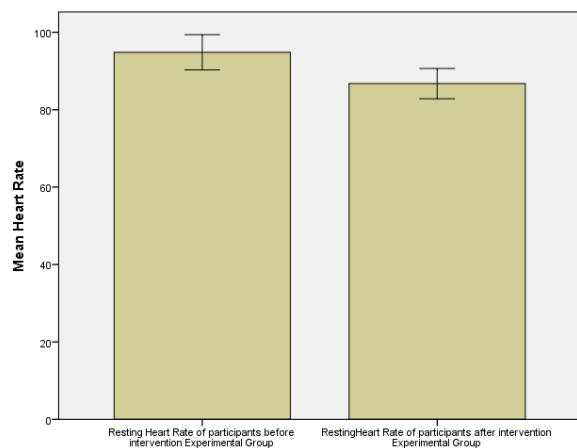


Figure 1. Heart Rate CG Before and After Intervention

In the pre-test, the heart rate (mean±SD) measured was 94.50±6.289 and at the end of 12 weeks, the heart rate (mean±SD) was 93.83±5.132 t-value 1.000 and the p-value of .339 greater than the alpha value of 0.05. The results clearly showed that not participating in any type of exercise may harm our heart rate, leading to different chronic diseases.

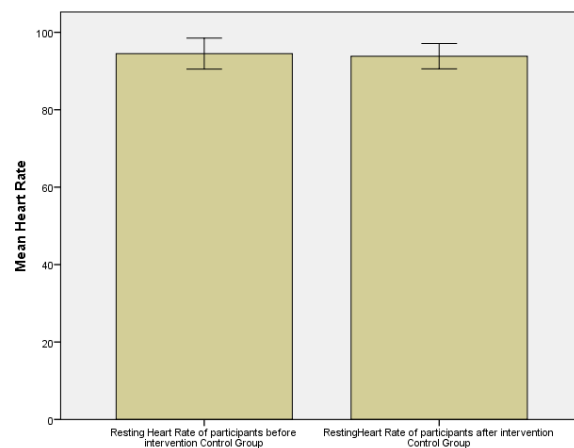


Figure 2. Heart Rate EG Before and After Intervention

Table 3. Paired sample T-test - the difference between Pre and Post-test Respiratory Rate (Experimental and Control Group)

Name of Variable	Group	Pre-test score (Mean ± SD)	Post-test score (Mean ± SD)	Pre- and Post-test scores (Mean ± SD) differences	t	Sig. (2-tailed)
Respiratory Rate	Experimental	22.25±1.815	19.50±1.679	2.750±1.357	7.021	.000
	Control	22.17±2.167	22.50±1.567	-.333±1.371	-.842	.417

$P < 0.05$ , SD=Standard Deviation

Table 3 shows a significant difference in the Respiratory Rate of participants of an experimental group which points towards a constructive effect of circuit training on the Respiratory Rate of participants. In the pre-

test the Respiratory rate (mean±SD) was 22.25±1.815 and at the end of the 12-week circuit training intervention respiratory rate (mean±SD) was 19.50±1.679 t-value 7.021, and p-value .000. The reason behind the

reduction in respiratory rate was regular circuit training. The results clearly showed that regular circuit training can reduce the respiratory rate among adolescents. Also, an insignificant effect on the resting respiratory rate of participants of the control group points towards a negative effect of not participating in any training program. In the pre-test, the

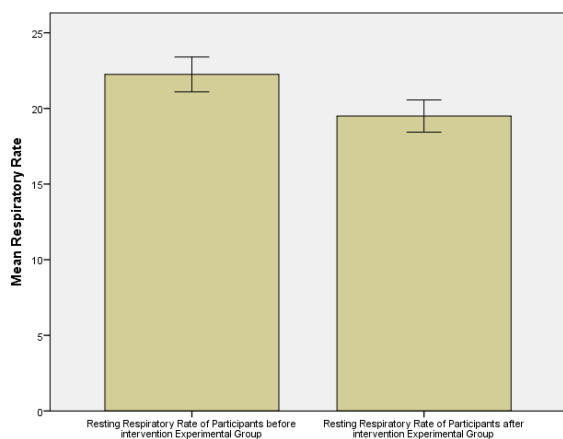


Figure 3. Respiratory Rate EG Before and After Intervention

## Discussion

During the Pre-test, the mean value of Heart Rate for the experimental group was  $94.83 \pm 7.158$  and after 12 weeks of intervention, the mean value of heart rate for the experimental group was  $86.75 \pm 6.166$  showing a positive decrease in resting heart rate at the end of the intervention. It shows that if you daily engage in a circuit training exercise 5 days a week can improve your resting heart rate. On the other hand, the pre-test value of the heart rate for the control group was  $94.50 \pm 6.289$  whereas, at the end of 12 weeks, the mean value of heart rate for

respiratory rate (mean $\pm$ sd) was  $22.17 \pm 2.167$  and at the end of the 12 weeks, the respiratory rate (mean $\pm$ sd) was  $22.50 \pm 1.567$  t-value  $-0.842$  and p-value  $.417$ . The results clearly showed that not participating in any type of exercise may harm respiratory rate leading to different chronic diseases.

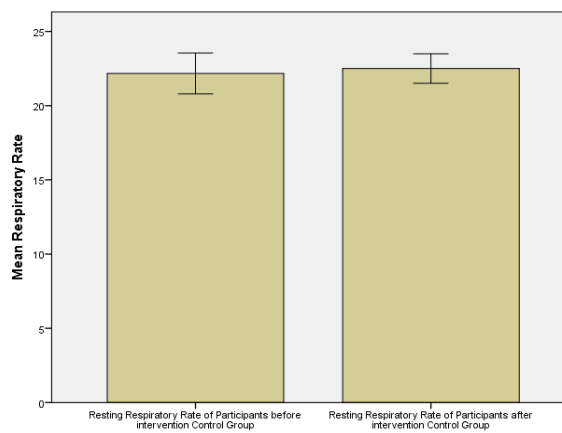


Figure 4. Respiratory Rate CG Before and After Intervention

the control group was  $93.83 \pm 5.132$  showing no such positive effect on heart rate. It shows that if an individual is not exercising it may harm his heart health after some time. It means that if an individual's heart rate is normal now and he is not exercising after some time his heart rate may affect his health. The findings of the current study are in line with the study findings of (Themistocleous et al., 2021) which showed the benefits of intermittent circuit exercise at a moderate intensity on the heart rate among obese and

overweight people, but participants of that study were aging between 18-55.

Moreover, Ikenna et al. (2020) asserted the benefits of circuit training on heart rate by getting the findings from a healthy female adult population. After the current study, it was also concluded that circuit training had benefitted the Heart Rate of male adolescents aged between 16-19 years.

Respiratory rates are also significantly affected by circuit training of 12 weeks and 5 days a week. During the pre-test, the mean value of the Respiratory Rate for the experimental group was  $22.25 \pm 1.815$  and after a 12-week intervention, the mean value of the respiratory rate for the experimental group was  $19.50 \pm 1.679$ . It shows that if you are engaged in circuit training 5 days a week it may positively decrease your respiratory rate. On the other hand, the pre-test value of the respiratory rate for the control group was  $22.17 \pm 2.167$  and at the end of 12 weeks, the post-test value for respiratory rate was  $22.50 \pm 1.567$  showing no such change in the control group. The findings of the current study are in line with the study findings of (Themaretocleous et al., 2021) which showed the benefits of intermittent circuit exercise at a moderate intensity on the respiratory rate among obese and overweight people, but

participants of that study were aging between 18-55. Moreover, (Ikenna et al., 2020) showed the benefits of circuit training on the respiratory rate by getting the findings from a healthy female adult population. After the current study, it was also concluded that circuit training had benefitted the Respiratory Rate of male adolescents aged between 16-19 years.

### **Conclusion**

The main objective of this research study was to determine the effect of circuit training on cardiorespiratory endurance among adolescents. So, the researchers analyzed that circuit training has a positive effect on selected variables of cardiorespiratory endurance (Heart Rate, Respiratory Rate) among adolescents aged 16-19 years.

### **Limitations**

1. Proper diet control for the participants is the main limitation of this particular study.
2. Disturbance in training protocol time due to the absentee ratio of participant students at Government College of Management Sciences, Haripur.
3. A 1-week break in intervention due to winter vacation at the college.



## Recommendations

1. Public awareness regarding the health dangers associated with obesity, heart disease, and respiratory disorders, and the benefits of circuit training may be raised through seminars, workshops, and conferences.

2. The training routine can be an effective tool for maintaining excellent health, by lowering the heart rate of adolescents aged 16-19 years.

3. The training routine can be an effective tool for maintaining excellent health, by lowering respiratory rate aged 16-19 years.

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