

Effects of Circuit Training upon Muscular Endurance among College Students

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Abstract

Health-related physical fitness is indispensable for every person irrespective of age; profession and gender to lead a healthy life. One of the key components of health-related physical fitness is muscular endurance. The main objective of this very study was to determine the “effects of Circuit Training upon muscular endurance among college students”. The participants of the study were hostel students of Government Post Graduate College Karak (Khyber Pakhtunkhwa) Pakistan. A sample of thirty students (n=30) were selected as subjects for the current study through Physical Activity Readiness Questionnaire (PAR-Q). Further the selected subjects were equally and randomly divided into two groups which were Experimental Group (Circuit Training) and Control Group (No treatment). The pre-test data on muscular endurance was obtained through one minute sit-ups test. The treatment of Circuit Training was given to experimental group on alternate days (Monday, Wednesday and Friday) for twelve weeks. No special kind of training was given to the control group in the same time except the subjects continued their routine life engagements. After 12 weeks’

treatment, the post-test data on muscular endurance was obtained through the test adopted for the pre-test. The pre-test data and post-test date was analyzed by applying the descriptive statistical sources (Mean, Standard Deviation, minimum, maximum) and inferential statistical tools (independent sample t test and paired sample t test). The significance level was fixed at 0.05 to test the hypotheses. The results of the study showed that Circuit Training has significant effects on muscular endurance. The control group did not show any sort of significant improvement in muscular endurance because it was not given any sort of treatment. It was concluded that in order for people to ameliorate their muscular endurance which is one of the key components of physical fitness, they should partake regularly in Circuit Training.

Key words: Circuit training, muscular endurance, college students

Introduction

Physical fitness has been the fundamental element of an individual life. It is considered as one of the most important possessions and has been established as high priority in all thoughts and actions. Physical fitness is the important thing for all individuals irrespective of age, profession, gender etc. in order to lead a healthy life and actively perform the routine life engagements (Katapallyet *al.*, 2016). The importance of physical fitness has been recognized by all and sundry in each and every stage of life. Physical fitness is a gift of life as it improves general health which paves the way to full and enthusiastic living. It provides a base for creative and dynamic activity (Mondal, Goon & Varghese, 2014). The progress and prosperity of a nation depends upon its healthy and fit citizens. Fit citizens are more prepared and keener to do things. They are more creative. They are mentally sharper, physically active and more in tune with body and, hence, perform daily assigned tasks efficiently and effectively (Rudkin, 2020). Physical fitness may be defined as the state of complete physical fitness renders the person to affectively discharge the everyday assignments and still having some reserve energy to work under stress for a longer period. It is the capability of different systems of the body that enables the person to give maximum out-put for a longer duration without being fatigued or exhausted (Griban *et al.*, 2020).

Physical fitness is divided into skill-related physical fitness and health-related physical fitness. Skill-related physical fitness is also known as motor performance fitness. The components of skill-related fitness are those components which are imperative for the attainment of motor skills, better performance and for participation in recreational activities and sports (Temple, Crane, Brown, Williams & Bell, 2016). Health-related physical fitness is so called because it is related to the general health. It is the ability to protect against diseases, manage muscles and joint disorders, strive to be mentally balanced and socially well adjusted. Simply, it is the capacity to become and stay physically healthy (de Castro Pinto, Cruz, de Pinho& de Dias Marques, 2020).

Health-related physical fitness favors those factors that promote optimum health and prevent diseases and disorders that are associated to lack of participation in physical activity. The general well-being is measured on the basis of health-related physical fitness. It also provides a base for the skill-related physical fitness. Health-related physical fitness is the path-way to skill-related physical fitness (Dentroet *al.*, 2014). Muscular endurance is one of the important components of health-related physical fitness. It is the capacity of the muscles to continue an activity of low to moderate intensity for longer period of time without fatigue (Ramalingam, 2019). It makes an individual to do daily tasks easily that paves the way to high quality of life. It helps to maintain good posture and prevent the injuries to utmost extent. It assists an individual to keep going an activity for a longer time without being prone to potential injuries (Toscano, 2018). All the methods used for measuring the muscular endurance, whether these are of lab or field tests, are connected to the number of repetitions that can be executed by the definite muscle group being tested. It can be measured isometrically or isotonicly (Ojanen, Häkkinen, Vasankari&Kyröläinen, 2018).

Performing the sit ups or chin-ups test for one minute is frequently used to find out the level of muscular endurance of a person (Kasteret *al.*, 2020). The endurance efficiency of the muscles is enhanced through regular participation in the activities like walking, jogging, cycling or dancing (Krespi, Sporis& Popovic, 2019). Lifestyle, nutrition, hydration, proper rest and sleep are some of the essentials that pave the way to achieve health-related physical fitness. Besides the stated elements, taking of exercises is fundamental for optimal health-related physical fitness (Trajković,Madić, Andrašić, Milanović&Radanović, 2017). Training is a program of exercises which is planned for the improvement of physical fitness (Stewart, Saunders & Greig, 2014).

Circuit training is one of the training methods. The credit goes to K. E. Morgan and G. T. Anderson for the development of modern Circuit Training in the year 1953 at the University of Leeds that is located in England. From the very beginning, there were 9-12 exercises in protocol. The partakers took exercise at the intensity which was moderate (40% to 60% of Repetition Maximum RM values) for a specific number of repetition or quantity of time. The participant moved to another station of exercise with little rest after the specific number of repetitions or expiration of the specific time. It became very popular and expanded because of its specific characteristics (Kravitz, 1996).

Circuit Training is a method of resistance training in which body weight or weight equipments are used as resistance while performing exercises (Klika & Jordan, 2013). The exercises can be performed horizontally or vertically. In horizontal type of training, all sets of exercise are performed before moving to another station. In vertical type of training, one set of each exercise is performed before returning to an exercise for another time (Nash, van de Ven, van Elk & Johnson, 2007). Circuit Training can be performed either on the basis of continuous method or interval method. In continuous method, all the exercises are performed one after the other without break/pause. In case of interval method, incomplete rest is given after each exercise because the HR is elevated very high and then returns to lower. The heart does not return to resting rate (Ballesta-García, Martínez-González-Moro, Rubio-Arias & Carrasco-Poyatos, 2019). There is usually a little time for recovery between the sets (Singh, 1991).

It enhances all muscles of the body and burns high calories in a short amount of time. It is ideal for the beginners as well as for the athletes. It can be adopted indoor as well as outdoor. It allows more people for participation in the same exercise session (Naikoo, Bhat & Bhat, 2017). It uses the technique of interval training that minimizes the rest interval between sets and exercise. In order to elicit maximum gains in short time, the resistance worked over to increase intensity and reduce the rest time (Klika& Jordan, 2013). The exercises of Circuit Training should be sequenced and ordered in such a manner that allow for opposing muscles groups to alternate resting and working in subsequent exercise station. First the exercise should be of whole body in order to elevate the heart rate. Then the exercise using the upper body should be followed by the exercise associated with lower body muscles and vice versa which maintains the increased heart rate.

The literature review of Hamoudat (2008); Ghassab & Oudat (2007) and Al-Rashidi (2006) has shown the decline of the components of physical fitness among college students. In Pakistan especially in

the province of Khyber Pakhtunkhwa (KP), no such study has yet been undertaken to find out the effects of physical activities on health-related physical fitness especially on muscular endurance. In fact, Circuit Training is designed for muscular endurance. We need to identify whether and how much Circuit training ameliorate the muscular endurance which is one of the key components of health-related physical fitness. With this perspective, the researcher intended to find out the “effects of Circuit Training upon muscular endurance among college students”.

Objectives of the study

- To determine the effects of circuit training upon muscular endurance among college students
- To suggest a list of recommendations for the enhancement of muscular endurance among college students

Delimitations of the study

- 1) Thirty students of GPGC Karak, who were residing in the college hostel, were taken as subjects.
- 2) The age range of the subjects was 18-22 years.
- 3) The study was restricted to male subjects only.
- 4) Two groups were formed each of fifteen students which were experimental group and Control Group.
- 5) The duration of Circuit Training was twelve weeks with three sessions per week on alternate days (Monday, Wednesday and Friday).

Materials and methods

Participants of the Study

In experimental research, participants of the study are the aggregate of all the subjects, objects or members that are directly related to the under-taken problem in connection with collection of the necessary data (Khirikoekkonget *al.*, 2020). Government Post Graduate College of district Karak was chosen for the study. Karak is located in the south of Khyber Pakhtunkhwa (province) of Pakistan. The participants of the study were comprised all the students (18-22 years) who were residing in the hostel of GPGC Karak and the total number of the students in hostel was one hundred and forty-two.

Exclusion/inclusion criteria

In order to select the proper/fit subjects, Physical Activity Readiness Questionnaire (PAR-Q) was used as exclusion and inclusion criteria. The PAR-Q is a screening tool. It usually consists of close ended questions and fitness trainers use it before start of exercise program in order to select right subjects and avoid the possible health risks (Warburton, Jamnik, Bredin & Gledhill, 2011). For this particular study, the students who were not a boarding in hostel were excluded. Students with diseases of heart, chest, unconsciousness, musculo-skeletal, hypertension and joints were not made the part of subjects. Further, the students who had been already taking part in aerobic or anaerobic activities for the last six months, past or present smoking history, having any sort of physical deformity, systemic illness and on acute or chronic medication were excluded. The subjects age range was 18 to 22years and no student was included as subject in the study whose age was above or below the stated range.

Selection of subjects

After the distribution and collection of PAR-Q among one hundred and forty-two students, seventy-two students were fit for participation in the study. Among the seventy-two students, thirty students were selected randomly as subjects for the in-hand study. Further the selected subjects were equally and randomly divided into two groups each one of fifteen subjects which were Experimental Group (Circuit Training) and Control Group (No treatment).

Instrument for collection of data

Instrument is a measurement device. In research study, instrument is a tool that researcher uses for the collection of data (Kola, 2017). There are various instruments like questionnaire, interview, test etc., and the selection of instrument depends upon the nature of study (Harris & Brown, 2010). The current study was undertaken to determine the effects of Circuit Training upon muscular endurance among college students. According to the available literature, knee bent sit ups test was selected for the collection of data on muscular strength. The knee bent sit ups performed in one-minute were recorded in number (Lovecchioet *al.*, 2019).

Test administration

3. Muscular endurance

- It was measured through knee bent sit ups for one minute (Sparling, 1997).

Purpose

- The main purpose of this test was to assess the muscular endurance.

Equipment

- A stop watch and mat.

Procedure

After warm up, each subject was asked to take a supine lying position on mat with bent knees (angle less than 90 degree) and feet flat on the floor. The subject put his hands beside the ears and his feet were held by the next coming subject for the test. The subject performed sit ups for one minute without any pause. He lifted his trunk, head and elbow forward until his elbows touched the thighs. Then he lowered the upper body until the shoulders blades touch the floor and thus one sit-up was counted. Bouncing and arching of lower back was not allowed. The buttocks must remain in contact with the floor throughout the test.

Scoring

- The numbers of correctly executed sit ups in one minute were recorded.

Orientation of subjects

The aim of the orientation is to get the reliable data. In order to motivate and involve the subjects in the selected tests and training, an orientation class was organized. The researcher explained the subjects' role as well as the purpose and importance of the present study. The researcher explained the procedure of testing on dependent variable to all the subjects of two groups and gave instructions about the procedure to be adopted by them for measuring. Besides orientation class, the researcher spent three sessions with experimental group to make acquainted the subjects with the techniques/procedure involved in the performance of exercises of circuit training so that they may perform the exercises properly and avoid the possible risks of injuries. The researcher himself gave the demonstration of each exercise in front of the subjects.

Pilot study

Keeping in view the limitations of the subjects for satisfaction, a pilot study was carried out to evaluate the initial capability of the subjects and ensure the suitability, frequencies and duration of training program (Circuit training). For this purpose, ten subjects were selected at random and went through Circuit Training. The average performance of ten subjects was calculated. The protocol of circuit training of 12 weeks was designed for experimental group on the basis of the response of the subjects in the pilot study. The basic principles of training were also followed by the researcher while designing the training protocol.

Protocol of circuit training

A self-administered Circuit Training protocol of 12 weeks was developed for the subjects of experimental group A. The intensity of exercise was 50% to 60% of Maximum Heart Rate (220-age) for the first six weeks while 60% to 70% of MHR for the last six weeks. Training session was started and concluded with warm up (light dynamic stretching exercises and walk) and warm down (Walk, light stretching exercises with deep breath) respectively each of 10 minutes. Prior to the start of training, each exercise was explained and demonstrated to the subjects so that all the exercises may be executed correctly. After the warm up session, the subjects performed Circuit Training exercises (Jumping jack, Sit ups with straight legs, Heel raising, abdominal crunch, Knee highs, push-ups, Legs raising, Burpees/plank, Light jumping and Lunges) on the basis of interval method i.e. there was pause between exercises. All the exercises were performed vertically. There was no restriction on the subjects for the repetitions of exercises but the subjects had to do it continuously till the end of stipulated time within heart rate zone. On whistle, the subjects started exercise allotted to the particular station. At the end of stipulated time for exercise, the whistle was blown and the subjects had to proceed to next station in the clock wise direction. There was also rest interval between sets.

Ethical consideration of the study

It becomes the responsibility of the researcher not to put the subjects in a situation where they might be at risk of getting physically and psychologically injures owing to their participation in the study. For this purpose, all the subjects were clearly informed about the purpose and procedure of study. The subjects were selected through PAR-Q which ensured that they were free from different diseases. A written consent was obtained from each subject. Likewise, a consent letter was also got from the head of the institution.

Analyses of the data

Section A: Descriptive analyses

Table 1. Anthropometrics/demographic measurements of age, height and weight of the subjects of Experimental group and Control group.

Groups	Variables	N	Minimum	Maximum	Mean	Std. Deviation
Experimental Group	Age (years)		18.00	22.00	19.47	1.35
	Height (cm)	15	163.00	184.00	173.07	6.82
	Weight (kg)		55.00	80.00	65.53	8.39

Control Group	Age (years)		18.00	22.00	20.47	1.46
	Height (cm)	15	160.00	178.00	169.27	4.95
	Weight (kg)		59.00	78.00	64.33	5.16

Section B: Inferential analyses

Pre-treatment matching process

Table 2. Pre-treatment Comparison among age, height and weight measurements of Experimental group and Control group.

Variables	Groups	N	Mean	St. Dev	Std. Error	df	t	Sig.
Age (years)	Experimental Group	15	19.47	1.35	.35	28	1.946	.062
	Control Group	15	20.47	1.46	.378			
Height (cm)	Experimental Group	15	173.07	6.82	1.76	28	1.747	.092
	Control Group	15	169.27	4.95	1.28			
Weight (kg)	Experimental Group	15	65.53	8.39	2.17	28	.472	.641
	Control Group	15	64.33	5.164	1.33			

The table shows that there is no significant difference (0.05) among age, height and weight measurements between Experimental group and Control group before the treatment.

Table 3. Pre-treatment difference between the muscular endurance of Experimental group and Control group

Variable	Groups	N	Mean	Std. Dev	Std. Error Mean	df	t	Sig.
Muscular Endurance (pre-test)	Experimental Group	15	25.40	4.26	1.09	28	.394	.696
	Control Group	15	24.60	6.61	1.71			

The table indicates that there is no significant difference ($.696 > \alpha = 0.05$) in muscular endurance between experimental group ($M=25.40 \pm 4.26$) and control group ($M=24.60 \pm 6.61$) before the treatment of circuit training.

Pre-test and post-test comparison of muscular endurance of each group

Table 4. Pre-test and post-test comparison of each group (Experimental Control and Control group)

Groups	Variable	N	Mean	Std. Dev	Mean difference	df	Sig.
Experimental Group	Muscular Endurance (pre-test)	15	25.40	4.26	9.40	28	.000
	Muscular Endurance (post-test)		34.80	4.00			
Control Group	Muscular Endurance (pre-test)	15	24.60	6.61	-.40	28	.458
	Muscular Endurance (post-test)		25.00	6.53			

The table shows that there is significant difference ($.000 < \alpha = 0.05$) in muscular endurance between the pre-test and post-test of experimental group ($25.40 \text{ cm} < 34.80 \text{ cm}$, Improvement= 9.40cm) however there is no significant difference ($.458 > \alpha = 0.05$) in muscular endurance between the pre-test and post-test of control group ($24.60 \text{ cm} > 25.00 \text{ cm}$, Improvement= -0.40 cm).

Table 5. Post-test comparison of muscular endurance between Experimental group and Control group

Variable	Groups	N	Mean	Std. Dev	Std. Error Mean	df	t	Sig
Muscular Endurance(post-test)	Experimental Group	15	34.80	4.00	1.03	28	4.952	.000
	Control Group	15	25.00	6.53	1.69			

The table shows that there is significant difference ($.000 < \alpha = 0.05$) between the post test in muscular endurance of experimental group and control group i.e. the treatment of circuit training has significant effects on muscular endurance.

Discussion

The results of the current study showed significant improvement positively of Circuit Training i.e. ($p < 0.05$) on muscular endurance. The study conducted by Mayorga-Vega, Viciano & Cocca (2013) also pointed out that Circuit Training program significantly improved muscular endurance. In the mentioned study, the subjects were given Circuit Training twice a week for 8 weeks. Their age range was 10 to 12 years. While in the current study, the treatment of Circuit Training was given three times/week on alternate days for 12 weeks to the subjects of age between 18 to 22 years. In spite of the difference between the two studies with reference to age, frequency of sessions and duration of training, both studies support findings of each other and showed that Circuit Training significantly enhanced muscular endurance.

Similarly, a study was also conducted by Kim, Ko, Seo & Kim (2018) to find out the effects of Circuit Training on muscular endurance. Though obese female students were selected as subjects for the study yet the Circuit Training enhanced muscular endurance among them. Thus, the findings of the current study endorse the findings of the mentioned study in perspective of the development of muscular endurance which is one of the key components of health-related physical fitness.

Finding of the study

The hypothesis of the study was about the effects of Circuit Training upon muscular endurance among college students (18-22 years). On the pretext of the chosen literature, it was conjectured that there would be significant effects of Circuit Training on muscular endurance among college students (18-22

years).It was revealed once the data was analyzed that Circuit Training has significant effects on muscular endurance ($P<0.05$) hence the hypothesis H1 is hereby accepted

Conclusion

The objective of the study was to identify the effects of Circuit training on muscular endurance among the college students (18-22 years).After analyses of the data, it was concluded that Circuit Training of 12 weeks had significant effects on muscular endurance among the college students (18-22 years) compared to control group.

Recommendations

Keeping in view the finding and conclusion, the following recommendations are made:

1. As the researcher found in the current study that Circuit Training exercises can improve muscular endurance of college students hence this program may be added to their regular working schedule. For this purpose, it is recommended to the government that a curriculum may be designed for the college students with selected exercises from circuit training in order to enhance muscular endurance in better way.
2. In Circuit Training a number of students can be engaged at a time. It is recommended to the government that a comprehensive program of Circuit Training may be introduced in other educational institutions for the enhancement of muscular endurance of students.
3. The Circuit Training exercises may be included in Health and Physical Education curriculum for the students at all levels.
4. The exercises of Circuit Training can be performed without any apparatus/equipment and hence these may be initiated by government and non-government organizations during working hours for the enhancement of muscular endurance of their employees and muscular endurance is one of the important components of health-related physical fitness.
5. The exercises of Circuit Training are simple form of exercises and these may be recommended for the masses in order to ameliorate their muscular endurance.
6. Fit citizens are the assets of a nation for they may play their role in better way in the development of country. It is recommended to the government to provide infrastructure (indoor and outdoor) to the masses for physical activities that will pave the way for fitter citizens.

7. It is recommended for the sports trainers and physical trainers to include exercises of Circuit Training in their training protocols for the improvement of muscular endurance of their athletes/trainees which is one of the key components of health-related physical fitness and health-related physical fitness provides a base for skill-related physical fitness.

The implications for future researchers

1. The researcher investigated the effects of Circuit Training upon muscular endurance among college students. The future researchers may extend the studies to university and school students.
2. The current study was confined to the students of 18 to 22 years' age. In future, the researchers may take different age group students to conduct similar studies.
3. Only the male students were taken as subjects for the current study. In future, similar studies may also be made on female students of the same as well as of different age group.
4. The researcher took the Circuit Training method as independent variable. In future, the researchers may take other training methods as independent variables in order to identify its effects on muscular endurance.
5. In the current study, muscular endurance was dependent variable. The researchers may include psychological, physiological, sociological and bio chemical variables to conduct similar studies by applying the same training protocol.
6. In the present study, the duration of Circuit Training was 12 weeks with three sessions per week on alternate days. The future researchers may investigate the effects of Circuit Training on muscular endurance with different intensity, frequency and duration.

Limitations and future directions

1. In the current study, psychological factors, food habits and life style of the subjects were not controlled. The future investigations may be extended to the stated variables in order to enhance the existing understanding.
2. Weather conditions like humidity, atmosphere temperature etc. were not taken into consideration. The future researcher might be interested to take into account the weather condition which would be helpful in better understanding of the phenomena.

3. The heredity differences were overlooked in the current study. The future researchers may take into account the heredity differences in their investigations in order to highlight the effects of Circuit Training upon muscular endurance in depth.
4. In the present study, there was no consideration of the subjects' social, economic and cultural background. The future researchers may include the stated variables in their investigations in order to broaden the scope of current study.

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