
Effect of Circuit Training upon Muscular Strength 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 strength. The prime objective of the current study was to determine the “effect of Circuit Training upon the muscular strength 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 strength of each subject was obtained through one minute push-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 strength of each subject was obtained through the test adopted for the pre-test. The pre-test data and post-test data was analyzed by applying the descriptive statistical sources (Mean, Standard Deviation, minimum and 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 hypothesis. The results of the study showed that Circuit Training has significant effects on muscular strength. The control group did not show any improvement in muscular strength because it was not given any sort of treatment. It was concluded that in order for people to ameliorate their muscular strength which is one of the key components of physical fitness, they should partake regularly in Circuit Training.

Key words: Circuit Training, muscular strength, 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 (Katapally *et 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 ability to perform efficiently and effectively the aspects related to sports, occupations and daily activities (Kokkinos, Giannelou, Manolis & Pittaras, 2009).

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. It is that kind of fitness that is associated with the athletic ability and mostly used in the field of sports (Jaraniet *al.*, 2016).

Health-related physical fitness is so called because it is related to the general health. It is the capacity of a person to perform daily routine tasks without undue fatigue and prevent from hypokinetic diseases and disorders that affect functional capacity of the body (Short, 2016).

Health-related physical fitness has five components and the development of these components is essential for optimum health. The components are muscular strength and muscular endurance, body composition, cardio-respiratory endurance and flexibility, (Ramírez-Vélez, Rodrigues-Bezerra, Correa-Bautista, Izquierdo & Lobelo, 2015).

Muscular strength is one of the key components of physical fitness. It is the quality of a muscle or set of muscles to generate utmost force in a single effort (Smith *et al.*, 2014). Strength, which is essential for every nature of physical activity and sports, is made available by the muscles of the body. The other components of physical fitness become worthless without it. It is the foundation for all movements. It is prerequisite for running, jumping, climbing, throwing, hitting etc. No physical activity can be carried out without it (Collins & Staples, 2017). Muscular strength and performance have direct relationship. It makes the life easy and comfortable because an individual

becomes able to execute the routine life activities with confidence and meet the challenges with inherent fight reaction. It alleviates daily aches and pains (Volaklis, Halle & Meisinger, 2015).

The enhancement of muscles can be ascribed to many factors i.e. initial strength, training, genetics etc. (Dankel *et al.*, 2017). Muscular strength may be developed by taking part in resistance type of activities like weight lifting, rapidly taking the stairs etc. (Toigo & Boutellier, 2006). Strength exercises increase the strength of the muscles. These exercises enhance hypertrophy of the muscles that pave the way for the production of greater force. Greater muscular strength supports many other physical and performance characteristics that help to improve an individual's overall performance in routine life appointments (American College of Sports Medicine, 2009). Generally, one can measure the strength of different muscles or group of muscles by asking an individual to do strengthening exercise and to determine by certain weight that an individual is able to lift. But there are various ways to measure the strength of the body. Dynamometer is a machine which is used to measure the strength of back, legs, hand grip and arm grip (Nicolas & Vobořil, 2017).

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 equipment's 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 strength. In fact, Circuit Training is designed for muscular strength. We need to identify whether and how much Circuit training ameliorate the muscular strength 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 strength among college students”.

Objectives of the study

- To determine the effects of circuit training upon muscular strength among college students
- To suggest a list of recommendations for the enhancement of muscular strength 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 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 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, a sample of thirty students (n=30) was 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 A (Circuit Training) and Control Group B (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 strength among college students. According to the available literature, push-ups/minute test was selected for the collection of data on muscular strength. The pus-ups performed in one-minute were recorded in number (Parry, Herrington & Horsley, 2020).

Test administration

Muscular strength was measured through push-ups performed in one minute. Mat and stop watch were used as equipments.

Procedure

After warm up, each subject was asked to take prone lying position on the mat with hands under the shoulders and fingers stretched. His legs were straight and parallel apart and the toes under the feet. After taking the stated position, with the command 'go', the subject performed push-ups with the arms extended completely. The back and legs were kept straight throughout the test. Then the subject lowered his body using the arms till they reach to 90-degree angle and upper arms parallel to the ground. One push-up was counted subject completed a cycle of up-down-up. The action was repeated as many times as possible in one minute.

Scoring

The total correctly executed push-ups per 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 of 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 respective 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 protocols.

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.

Statistical analyses

Section A: Descriptive analyses

Tale 1. *Demographic/ Anthropometric measurement of age, height and weight of the subjects of Experimental group and Control group.*

| Groups | | 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, weight and height 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 between the Experimental group and Control group before the treatment.

Table 3. *Pre-treatment difference between muscular strength of Experimental group and Control group*

| Variable | Groups | N | Mean | Std. Dev | Std. Error Mean | Df | t | Sig. |
|------------------------------|--------------------|----|-------|----------|-----------------|----|------|------|
| Muscular Strength (pre-test) | Experimental Group | 15 | 13.20 | 5.09 | 1.31 | 28 | .165 | .870 |
| | Control Group | 15 | 12.86 | 5.91 | 1.53 | | | |

The table indicates that there is no significant difference (.870 > $\alpha = 0.05$) in muscular strength between experimental group ($M=13.20 \pm 5.09$) and control group ($M=12.86 \pm 5.91$) before the treatment (circuit training).

Pre-test and post-test Comparisons of muscular strength of each group

Table 4. *Pre-test and Post-test comparison of muscular strength of Experimental group and Control group*

| Groups | Variable | N | Mean | Std. Dev | Mean diff | Df | Sig. |
|--------------------|-------------------------------|----|-------|----------|-----------|----|------|
| Experimental Group | Muscular Strength(pre-test) | 15 | 13.20 | 5.088 | -8.93 | | .000 |
| | Muscular Strength (post-test) | | 22.13 | 5.083 | | | |
| Control Group | Muscular Strength (pre-test) | 15 | 12.87 | 5.914 | -.73 | | .077 |
| | Muscular Strength(post-test) | | 13.60 | 5.329 | | | |

The table shows that there is significant difference ($.000 < \alpha = 0.05$) in muscular strength between the pre-test and post-test of experimental group (13.20 cm < 22.13 cm, Improvement = 8.93cm) however there is no significant difference ($.077 > \alpha = 0.05$) in flexibility between the pre-test and post-test of control group (12.87 cm > 13.60 cm, Improvement = -0.73 cm).

Post-test comparison between the Experimental group and Control group

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

| Variable | Groups | N | Mean | Std. Dev | Std. Error Mean | Df | t | Sig |
|-------------------------------|--------------------|----|-------|----------|-----------------|----|-------|------|
| Muscular Strength (post-test) | Experimental Group | 15 | 22.13 | 5.08 | 1.31 | 28 | 4.488 | .000 |
| | Control Group | 15 | 13.60 | 5.33 | 1.37 | | | |

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

Discussion

The results of the current study showed significant improvement positively of Circuit Training i.e. ($p < 0.05$) on muscular strength.

The study of Rengasamy (2012) contradicts the result of current study with reference to the muscular strength. The main reason behind the contradiction between the findings of both studies with regard to the muscular strength is their measurement method and protocol. In the current study, the muscular strength was measured with the test of push-ups performed/minute and there were also push-ups exercise in the protocol which significantly enhanced the muscular strength. In the study of Rengasamy (2012) the muscular strength was measured with hand dynamometer which only measures hand strength and perhaps no exercise was included in for the use of hands muscles.

Similarly, a study was also conducted by Kim, Ko, Seo & Kim (2018) to find out the effects of Circuit Training on muscular strength. Though obese female students were selected as subjects for the study yet the Circuit Training enhanced their muscular strength. Thus, the findings of the current study endorse the findings of the mentioned study in perspective of the development of muscular strength 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 strength among college students (18-22). From the extracted literature it was hypothesized that there would be significant effects of Circuit Training on muscular strength among college students (18-22 years). When the data of the current study was analyzed it was transpired that 12 weeks' Circuit Training has significant effects on muscular strength ($P < 0.05$) hence the hypothesis H1 is hereby accepted.

Conclusion

After analyses of the data, the following conclusion was drawn

The objective of the study was to identify the effects of Circuit training on muscular strength among the college students (18-22 years). It was concluded that Circuit Training of 12 weeks has significant effects on muscular strength 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 strength 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 strength in better way.

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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 strength 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 strength of their employees and muscular strength 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 strength.
 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 strength 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 strength 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 strength.
5. In the current study, muscular strength 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 strength 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. was 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 strength 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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