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Effect of eight-week callisthenics exercise on selected physical fitness quality and skill performance in handball

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Abstract

This study aimed to investigate the effect of eight-week callisthenics exercises on selected physical fitness qualities and skill performance in U-17 female handball players. The study utilized a quantitative research approach with an experimental design to achieve its goals. For this study, 20 female handball players were selected. The researcher employed a comprehensive sampling technique and randomly divided them into two equal groups: the experimental group (n = 10) and the control group (n = 10). During 8 weeks, the experimental group did callisthenics workouts three times weekly, while the control group stuck to regular handball training. The study assessed passing accuracy, dribbling speed, agility, and muscular strength in both groups before and after. The data collected from the participants were analyzed using SPSS version 24 software, employing paired sample t-tests and independent-sample t-tests with a significance level set at 0.05. The analysis revealed that callisthenics exercises significantly improved passing accuracy, speed dribble, agility, and muscular strength in the pre-post test of the experimental group ($p<0.05$). However, no significant differences were found in any control group variables ($p > 0.05$). Based on these findings, the eight-week callisthenics exercise program contributes to enhancing agility, muscular strength, passing accuracy, and speed dribbling in U-17 female handball project players.

Keywords: calisthenics exercise, muscular strength, speed dribbling, passing accuracy, agility.

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INTRODUCTION

Physical fitness is an essential aspect for individuals engaged in busy activities. Everyone must possess physical fitness, as it provides the energy to carry out all activities (Kljajević et al., 2022). In the realm of sports, physical fitness is highly intertwined; athletes with demanding schedules greatly rely on physical fitness. Physical fitness is an irreplaceable necessity for athletes as it

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fuels their performance in sports (Setiawan et al., 2020). However, the current issue lies in the frequent oversight of physical fitness, considering that numerous talent evaluations in sports are not based on physical fitness. Athletes must maintain physical fitness within their bodies as it fuels their athletic endeavours (Zhan & Cui, 2023). To reach peak performance, athletes need physical fitness that aligns with the specifications of their sport. Fulfilling physical fitness can be achieved by athletes through engaging in physical training.

Physical exercise has been proven to measure the effects of training on various human body systems. Various exercise responses exist based on different types of exercises and training programs (such as strength and agility), age, gender, and fitness levels. The activities required for different categories of people are adjusted according to their abilities. This ensures the quality of life for individuals engaging in these activities. Today, there is a unique opportunity to contribute to a positive, healthy lifestyle for every individual (Ramirez-Campillo et al., 2018). There are studies in the literature that convey the positive effects of callisthenics exercises on body composition (Zarco et al., 2022), VO2max (Alonso-Fernández et al., 2022), flexibility, anaerobic power, aerobic capacity, leg strength (Machado et al., 2019), power, flexibility, blood pressure, resting pulse (Thomas et al., 2017), total cholesterol, triglycerides, systolic-diastolic blood pressure and decrease in obesity rates (Zarco et al., 2022). Also, studies are reporting that callisthenics exercises reduce the negative effects of fatigue, insomnia, difficulty concentrating, and depression (Alonso-Fernández et al., 2022). Regular exercise has an important role in obesity, hyperglycemia, LDL, and blood pressure. Cardiovascular output and blood flow to working muscles increase throughout physical activity (Turgut & Sarikaya, 2020). In addition, simple motor skills impact performance (Petancevski et al., 2022).

Calisthenics is a form of exercise that consists of various movements without the use of equipment, but these exercises mainly use one's own body

weight as an exercise load. It is intended to increase the strength and flexibility of the body with movements such as bending, jumping, swinging, twisting or kicking; use one's weight for resistance. Callisthenics is an aerobic and dynamic exercise and is suitable for all ages, considering that this activity has a low risk of injury. This exercise is characterized by rhythm, smoothness, and fun that is easy to do alone or in a group format and can be modified according to the subject's fitness level. Callisthenics consists of various simple movements intended to increase body strength and flexibility using one's body weight for endurance. Callisthenics fitness training can develop muscular endurance and cardiovascular fitness in addition to improving psychomotor skills such as balance, agility and coordination. Callisthenics can benefit both muscles and cardiovascular fitness.

These callisthenics exercises are intended to provide a balanced, sufficient, flexible, and highly efficient complement to the daily workout companion. Combined with other exercise programs, callisthenics exercises allow us to systematically train our entire body and achieve body conditioning in a very short time (Carter & Gladwell, 2017). For most of us, callisthenics exercises will be done 3-5 days per week, and each exercise will last from 10-30 minutes (Prabhu et al., 2020). Calisthenics are performed at a low cost since these can mainly be done in open areas, and their ease, not requiring minimal equipment or equipment (such as high bars or parallel bars) has been seen to be effective for physical development and has gained increasing popularity over the years (Sandler et al., 2014).

Flexibility is key to sports performance but works alongside other motor variables like strength and agility, both directly and indirectly enhancing overall athletic ability (Rahman & Islam, 2020). Numerous variations exist, including different gymnastic movements, bounce exercises, push-ups, shuttle runs, pull-ups, lunges, planks, squats, sit-ups, crunches, dips, burpees, and mountain climbers. Calisthenics strength training is easily integrated into physical

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education classes, resulting in enhanced muscle strength (Guerra et al., 2019) and reduced pain intensity (Akyol et al., 2016).

Muscular strength refers to the capacity of a muscle or a group of muscles to exert force (Wang et al., 2017). Strength and power play pivotal roles in athletic excellence, and a robust connection exists between these two elements, significantly influencing an athlete's overall performance (Sommerfield et al., 2020; Suchomel et al., 2016). The pull-up test is widely used as a primary resistance exercise method for assessing upper-body muscle strength, endurance, or strength adaptations (Dickie et al., 2016; Mola & Bayisa, 2020; Reza et al., 2022; Ronai & Scibek, 2014). The Illinois Agility Test (IAT) is a widely used tool for training and evaluating the agility of athletes in various sports. It measures multidirectional agility, focusing on skills like acceleration, deceleration, multidirectional turning, and angled running (Hachana et al., 2013; Raya et al., 2013). In scientific training, focusing initially on agility exercises and short linear sprints can enhance dribbling performance (Islam & Kundu, 2020). Muscular strength and agility are fundamental components in the realm of sports performance, playing a pivotal role in the efficacy of specific skills such as passing accuracy and speed dribbling in handball. Researchers Ferragut et al. (2018) established a clear link between agility, enhanced reaction times, and improved dribbling speed. These findings are corroborated by (Mohamad et al., 2021), who stated that players' agility was directly related to their ability to execute rapid directional changes while maintaining ball control, a crucial factor in effective dribbling.

Numerous studies have demonstrated the positive effects of callisthenics exercises on athletic performance (Cigerci & Genc, 2020; Gist et al., 2015; Mear et al., 2022). Specifically, Hassan et al. (2022) noted improvements in agility and muscular strength, while Marwat et al. (2021) highlighted general physical fitness enhancements. However, the impact of callisthenics on handball-specific fitness elements like agility, muscular strength, and skills such as speed dribbling and passing accuracy have yet to be explored. This

study aims to determine if callisthenics can significantly improve these aspects in experimental versus control groups. This research is especially relevant given the observed challenges in physical fitness, passing accuracy, and speed dribbling among U-17 female handball players at Bahir Dar University, Ethiopia.

METHOD

Study design

The research adopted a truly experimental approach to explore how an 8-week callisthenics workout regimen impacted certain physical fitness attributes and skill performance in U-17 female handball players at Bahir Dar University, Ethiopia. The study involved twenty (N = 20) female U-17 handball players, who were randomly chosen and assigned into two groups: an experimental group (EG) with 10 players and a control group (CG) also comprising 10 players. The ages of these participants varied between 15 and 17 years. To qualify for the study, participants needed to pass health and physical readiness assessments, ensuring they were free from acute and chronic illnesses and any current physical or mental injuries. Those who failed to meet these standards were excluded. The study received approval from the departmental research committee, as it involved participants who volunteered, and verbal consent was secured.

Primary data was collected through pre and post-tests for both the experimental and control groups. Ethical considerations were taken into account, ensuring the participants' voluntary participation and their right to withdraw at any time. The study protocol was approved through a written consent form provided to the concerned parties. The experimental group underwent an 8-week training program, three days per week (on Monday, Wednesday, and Saturday), with each session lasting 40-45 minutes. The control group did not receive any additional training designed for the study. Tests were conducted before and after the training period. According to Mola

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& Bayisa (2020), a training program of 8 to 12 weeks is crucial for maximizing individuals' abilities.

Methods and Procedures of Data Collection

Quantitative data was collected to assess the effects of treatment exercises on selected physical fitness qualities and skill performance tests. The study assessed physical fitness through tests like the Illinois Agility Run for agility and pull-up tests for muscular strength. Handball skill performance was evaluated using passing accuracy tests at 7m and 10m distances and a speed dribble test involving obstacle dribbling. Before the experimental groups began the treatment exercise program, a pre-test was administered to both the control and experimental groups. After 8 weeks of treatment exercise in the experimental group, a post-test was conducted for both groups. Various materials and facilities were utilized to ensure the study's success, including cones, balls, walls, pens, stopwatches, whistles, record sheets, meters, and other relevant equipment. The tests were conducted in the following order: agility test (Illinois Agility Run), muscular strength test (pull-up), passing accuracy test (accuracy throw), and speed dribble test (obstacle dribble).

Reliability and Validity of Instruments

Test reliability was ensured by establishing the quality and essential equipment needed for the tests and the reliability of both the test itself and the trainees' performance. The researcher conducted practice sessions in the testing procedures under the guidance of respective experts to ensure uniformity and reliability in the testing technique. Furthermore, the researcher administered all the tests for the study with the assistance of professional experts. In addition, Cronbach's alpha reliability statistics for agility (0.83), muscular strength (0.87), passing accuracy (0.89), and speed dribble (0.90) were calculated, indicating the internal consistency and reliability of these measures.

Research Procedure

In the study, participants were randomly allocated into two groups: the control group underwent standard handball training, while the experimental group engaged in both callisthenics and regular handball training three times weekly for eight weeks. This experimental approach, outlined in several studies (Kumar, 2019; Panihar & Rani, 2022; Thomas et al., 2017), involved callisthenics sessions lasting 45 to 60 minutes, including warm-ups and cool-downs, on Mondays, Wednesdays, and Saturdays. The exercises included a variety of movements like foot tape, jumping squats, lunges, and chin-ups. Conversely, the control group did not participate in any specialized training during this period.

Statistical Analysis

The collected data were analyzed using descriptive and inferential statistics. Descriptive statistics included measures like mean, standard deviation, frequency distribution, and graphics, which were processed using SPSS Version 24 software to observe the physical fitness of the participants. Inferential statistics, on the other hand, involved the use of paired t-tests to compare pre-test and post-test results within both experimental and control groups. To ensure the data's normality, we examined the histogram and conducted the Shapiro-Wilk test. The study analysis was performed using an independent samples t-test to compare the selected physical fitness variables between the control and experimental groups, with a significance level set at 0.05.

RESULT

This study aimed to investigate the impact of an 8-week Calisthenics exercise program on selected physical fitness qualities and handball performance among Bahir Dar University U-17 female handball players. This chapter focuses on the analysis of pre and post-test data collected from randomly selected experimental (n=10) and control (n=10) groups. The

selected physical fitness components examined in this study were muscular strength and agility, while handball skill tests included passing accuracy and speed dribble. Pre-test and post-test measurements were taken from both groups before and after the 8-week callisthenics exercise intervention for the experimental group, and the scores were recorded.

The collected data were analyzed using paired sample t-tests to compare pre-test and post-test results of muscular strength, agility, passing accuracy, and speed dribbling within both the experimental and control groups. Additionally, an independent t-test was utilized to compare the pre-test and post-test results between the control and experimental groups.

Table 1. Paired sample t-test pre and post-test

Variable	Groups	Pre-Test	Post Test	Mean	SD	P
Agility	EG	20.40 ± 1.505	18.07 ± 0.533	2.33	1.1844	0.000
	CG	18.07 ± 0.533	18.07 ± 0.533	0.50	1.2693	0.244
Muscular Strength	EG	16.90 ± 1.969	12.90 ± 1.595	-2.60	1.3499	0.000
	CG	4.100 ± 0.994	4.800 ± 1.032	- 0.70	1.05935	0.066
Speed dribbling	EG	4.100 ± 0.994	4.800 ± 1.032	4.000	1.699	0.000
	CG	17.30 ± 2.002	16.70 ± 1.888	0.600	1.074	0.111
7m passing accuracy	EG	13.30 ± 4.321	20.50 ± 2.677	-7.200	2.3944	0.000
	CG	13.70 ± 3.267	13.70 ± 4.001	0.000	3.496	0.509
10m passing accuracy	EG	13.30 ± 4.321	20.50 ± 2.677	-3.600	2.0655	0.000
	CG	13.00 ± 3.162	13.50 ± 2.718	-0.500	2.718	0.575

Key: - $p < .05$; CG = control group, EG= experimental group, MD = mean difference, SD = Standard deviation.

Table 1 shows the variables assessed in both the EG and CG during the pre-test and post-test. Following the 8-week treatment training program, the EG exhibited noteworthy improvements in agility, muscular strength, 7m passing accuracy, 10m passing accuracy, and speed dribble ($p < 0.05$). Conversely, there was no significant difference between the pre-and post-test results in the CG ($p > 0.05$).

Table 2. Comparisons of measured variables between EG and CG in both pre-test and post-test

Variable	Pre-Test			Post-Test		
	MD	SD	P	MD	SD	P
Agility	20.8	1.26	0.185	19.385	0.93	0.000
Muscular strength	4.1	1.02	0.83	5.7	1.23	0.005
7m Passing accuracy	13.5	3.79	0.818	17	3.33	0.000
10m passing accuracy	13.7	3.52	0.390	15.75	2.97	0.004
Speed dribble	17.1	1.95	0.658	14.8	1.74	0.000

$p < .05$; CG = control group, EG = experimental group, MD = mean difference, P = P-Value, SD = Standard deviation

Table 2 presents comparisons of agility, muscular strength, 7m passing accuracy, 10m passing accuracy, and speed dribble between EG and CG before and after the treatment. The comparisons between groups in the pre-test revealed that there was no difference between variables ($p > 0.05$). In the post-test, agility, muscular strength, 7m passing accuracy, 10m passing accuracy, and speed dribble were higher in EG than CG ($p < 0.05$).

DISCUSSIONS

The main focus of this study was to examine the impact of an eight-week treatment exercise program on selected physical fitness qualities and handball skills among U-17 female handball players from Bahir Dar University. The findings showed that the experimental group experienced significant improvements in selected physical fitness qualities and handball skills, specifically in passing accuracy and speed dribble. However, the control group did not show significant changes in these aspects. The study also investigated the effects of callisthenics exercises on agility, muscular strength, and overall handball performance.

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The effect of calisthenics exercise on agility

The present study's findings indicate that treatment exercise significantly positively affects agility. This result is consistent with previous research by Panihar and Rani (2022) and Hassan et al. (2022), which all demonstrate the beneficial impact of treatment training on agility in different sports. Furthermore, the study suggests that callisthenics exercises can be recommended to players and coaches as a means to enhance agility performance in handball players. Additionally, the callisthenics exercise led to improvements in selected motor fitness variables, including agility, among slum boys (Herbert et al., 2020). Overall, the evidence from these studies supports the effectiveness of callisthenics exercises in enhancing agility and motor fitness performance, making them valuable training methods for athletes and coaches. Improvement in Callisthenics exercises was also observed, which showed more excellent agility results compared to the control group. These alterations can be attributed to certain neural adaptations, increased recruitment of motor units and improved coordination of the muscle groups involved (Zarco et al., 2022). Callisthenics exercises significantly positively affected selected motor fitness variables of speed and agility (Alonso-Fernández et al., 2022).

The effect of calisthenics exercise on muscular strength

This study confirms that treatment exercises significantly enhance muscular strength in handball players, evidenced by notable differences in post-test scores between the experimental and control groups. This is consistent with observations by other researchers who noted enhancements in muscle strength and endurance after comparable exercise programs (Kumar, 2019; Marwat et al., 2021). Thus, callisthenics is shown to be an effective method for boosting muscular strength in athletes. Calisthenics training is one of the effective training alternatives to increase the body's metabolism. Calisthenics training is an exercise that involves a variety of basic movements and can be performed by using body weight without the use of

any equipment (Akyol et al., 2016). Based on the previous study, calisthenic training is effective in improving fitness components such as reducing fat mass and increasing body mass (Cigerci & Genc, 2020), increasing aerobic capacity (Shete et al., 2014), improving muscle strength (Sommerfield et al., 2020).

The effect of calisthenics exercise on speed dribble

The study's findings indicate that callisthenics exercise significantly positively affects speed dribble performance. The results showed a significant difference in the paired t-test scores between the experimental group (EG) and the control group (CG) in the post-test ($p = 0.000$, $P<0.05$). Based on these results, callisthenics exercise is beneficial for improving the speed dribble performance of handball players. Researcher (Georgescu et al., 2019) indicates that engaging in a diverse range of callisthenics, including coordination exercises, within an experimental group can enhance fundamental speed dribbling abilities in handball. Indeed, callisthenics training is known to exploit the adaptation of stretch-shortening cycles through the neuromuscular system, which further helps to increase speed (Lester et al., 2014). Our findings indicate statistically significant improvements in speed in the research (handball). Our findings indicate that including the callisthenics training program with regular handball, training can improve the performance of the handball players, more specifically, by achieving more speed. Hence, callisthenics training improves various physical components such as speed, agility, explosive power, hamstring flexibility, and sports-specific skills.

The effect of calisthenics exercise on passing accuracy

The present study's findings indicate a significant positive effect of callisthenics exercise on 7m passing accuracy. The results show a significant difference in the paired t-test scores between the experimental group (EG) and the control group (CG) in the post-test ($p = 0.000$, $P<0.05$). Hollingsworth et al. (2020) further confirm that callisthenics exercise is an effective training method

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to enhance passing accuracy in handball players, and treatment can improve throwing accuracy in an experimental group (Rahman & Islam, 2020). Implementing gymnastic exercises improves important physical parameters, such as accuracy and sport-specific skills among handball players. Therefore, including callisthenics training programs can improve the overall performance of handball players by achieving more accuracy in throwing techniques in handball.

The study's findings highlight the significant impact of callisthenics exercises on enhancing essential physical and skill-related aspects of handball performance in young female athletes. This can be a guiding framework for coaches and trainers to incorporate similar training modules for the holistic development of handball players. This research suggests that callisthenics training programs in handball enhance athletes' physical abilities and skills. However, the study's limitations focus solely on the restricted physical capabilities and technical skills, involving only two components within each skill. These selected abilities represent the dominant skills present in handball. The subjects involved in this study were a women's handball team drawn from U-17 female handball players at Bahir Dar University, Ethiopia. Based on the outlined limitations, the implications of this research could be expanded upon. For instance, by incorporating additional dominant physical factors and comprehensive techniques in handball, the impact of callisthenics on these fundamental physical and technical factors could be explored. Subsequently, further research could involve developing subject characteristics such as male teams or comparing the effects on male versus female teams. This could involve athletes with proficient skills to generate more compelling and interesting results.

CONCLUSION

The study found that an eight-week callisthenics exercise program significantly improved agility, muscular strength, and skills like speed dribbling and passing accuracy in U-17 female handball players. Incorporating callisthenics into training programs can enhance physical fitness and handball performance. Future research could explore other fitness aspects and extend to different groups.

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