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Efficacy of an eight week soccer training programme on cardiovascular fitness: Case of Strathmore school, Nairobi city county, Kenya

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Abstract
Muscular fitness and cardiovascular endurance training plays a key role in adding value to the overall performance of soccer players. However, in Kenya, few soccer players, especially those of high school age, have embraced muscular fitness and cardiovascular endurance training. The study assessed the efficacy of an eight-week soccer training program on the cardiovascular fitness of Kenyan high school soccer team players. The study aimed to find out the impact of cardiovascular fitness training on the physical performance of the high school soccer players. The respondents comprised of the Strathmore school soccer team with a sample size (n=30) who underwent a before training test, the training programme, and after the programme test. The program involved their regular skill work, muscular fitness, and cardiovascular endurance training routine. STATA version 16 (IBM limited, UK, 2016) was used for processing data. To obtain means, percentages, standard deviations, and frequencies, descriptive statistics were calculated to analyze the status of the athletes after the training period. A paired T-test was used to test the hypotheses. The pre-test score of the athletes was (38.9133±5.73102) $V0_2$max. When compared to the test norms, it is in the fair category. After passing through the workout program, there was a significant improvement (41.663±5.34199) $V0_2$ max. This was a statistically significant increase of 2.75 t (29) =4.093, and effect size d = 0.741. The significant improvement of the of the $V0_2$ max of the participants shows that the $V0_2$max can be improved through the cardiovascular fitness training that was implemented.

Keywords: Cardiovascular endurance, physical performance

1. Introduction
As one of the most widely played sports globally, success in soccer requires players to be physically, tactically, and technically fit. However, studies on soccer performance improvement have often emphasized on tactics at the expense of resources on the physical aspects such as strength and endurance. Ideally, a well-conditioned soccer player should have the ability to maintain an intensity of high level throughout the whole game (Helgerud, Engen, Eislf & Hoff, 2015) [1]. Both the anaerobic and aerobic energy systems are required due to the intermittent exercise associated with soccer (Anderson *et al*., 2014) [2]. In order to improve players' performance, globally, the sport of soccer is rapidly being changed by the diverse and different modes of training (Ramirez *et al*., 2014) [3]. Most soccer teams in various leagues worldwide invest heavily on physical fitness to ensure that their players are always at the peak of their performance.

Cardiovascular fitness is quite essential in soccer. It plays a big role in influencing an athlete's overall performance (Daniel, 2019) [4]. An athlete's cardiovascular endurance is crucial as it enables the delivery of oxygen from the lungs of an athlete to the body cells. Oxygen is used for energy production (Daniel, 2019) [4]. An efficient cardiovascular endurance is essential, especially when an athlete requires energy for long durations (Daniel, 2019) [4]. Additionally, in sports, high cardiovascular endurance generally means performing high-intensity activities for a prolonged period (Eske, 2019) [5]. Hence the necessity of improved cardiovascular endurance (Eske, 2019) [5].

University and high school soccer teams embrace the aspects of strength and conditioning to their training routines.

In line with how training should be molded to represent technical and tactical aspects of soccer sports (Gaetano, 2022) [6], high aerobic capacity determines the ability to produce a variety of decisive actions during a 90-minute game. In addition, the capacity to produce an explosive single-bout effort is equally as crucial as aerobic power for succeeding in soccer. This includes frequently occurring movements in soccer such as kicking, throwing, changing direction, jumping, and sprinting (Ramirez *et al*., 2014) [3]. Therefore, cardiovascular fitness should be emphasized on considering the nature of the sport and how the different fitness demands come to play during soccer matches. This study investigated the efficacy of an eight-week conditioning programme on the cardiovascular fitness of a selected high school soccer team in Kenya.

2. Material and Method

2.1 Research Design

The research used a quasi-experimental design for data collection. The research group consists of the Strathmore Schools under-19 soccer teams, comprising the form three students. The team comprised of 30 players (n=30). Before the study, written permissions were taken from the participants and their guardians. During the data collection, the athletes passed through a high-intensity functional training programme focusing on cardiovascular fitness for 8 weeks, 2 days a week for 45 to 60minutes. The programme involved running, push-ups, tyre flips, tyre pulls, squats, chin ups, burpees, dips, calf raises, box jumps and stretches. Before the conditioning program, pre – tests were done. Post-tests were done after the program. The Kenyatta University Ethics Review Committee approved this study (KU-ERC) No. PKU/2247/I1391 and a permit was acquired from the National Commission for Science, Technology and Innovation, Ref No:285023.

2.2 Data Collection Tools

The study used shuttle run to gauge the athlete's cardiovascular endurance scores. This was done before and after the training programme. The test scores were further converted into $V0_{2max}$for easy analysis and interpretation.

2.3 Data Analysis

Data was analyzed using Stata version 16 (IBM limited, UK, 2016) and Microsoft Excel 2013 for Windows. Data collected was summarized and descriptive statistics of means, and standard deviation were used to determine the occurrences. The null hypothesis that there would be no significant difference in the cardiovascular endurance of Strathmore school soccer team players before and after the strength and conditioning program was tested at alpha level p=0.05.

3. Results

A paired-samples t-test was used to determine a statistically significant mean difference between the participants' shuttle-run repetitions before and after the conditioning program, as shown on Table 1 and Figure 1. There were no outliers detected. The assumption of normality was not violated, as assessed by Shapiro-Wilk's test (p = .1378).

Table 1: Paired t-test comparison of the shuttle run $V0_{2\ max}$ before and after the conditioning program

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
$V0_{2max2\ (Pre\text{-}test)}$	30	41.66333	.97531	5.341993	39.6686	43.65807
$V0_{2max1\ (Post\text{-}test)}$	30	38.91333	1.046337	5.731025	36.77333	41.05333
Diff	30	2.75	.6718434	3.679838	1.375926	4.124074

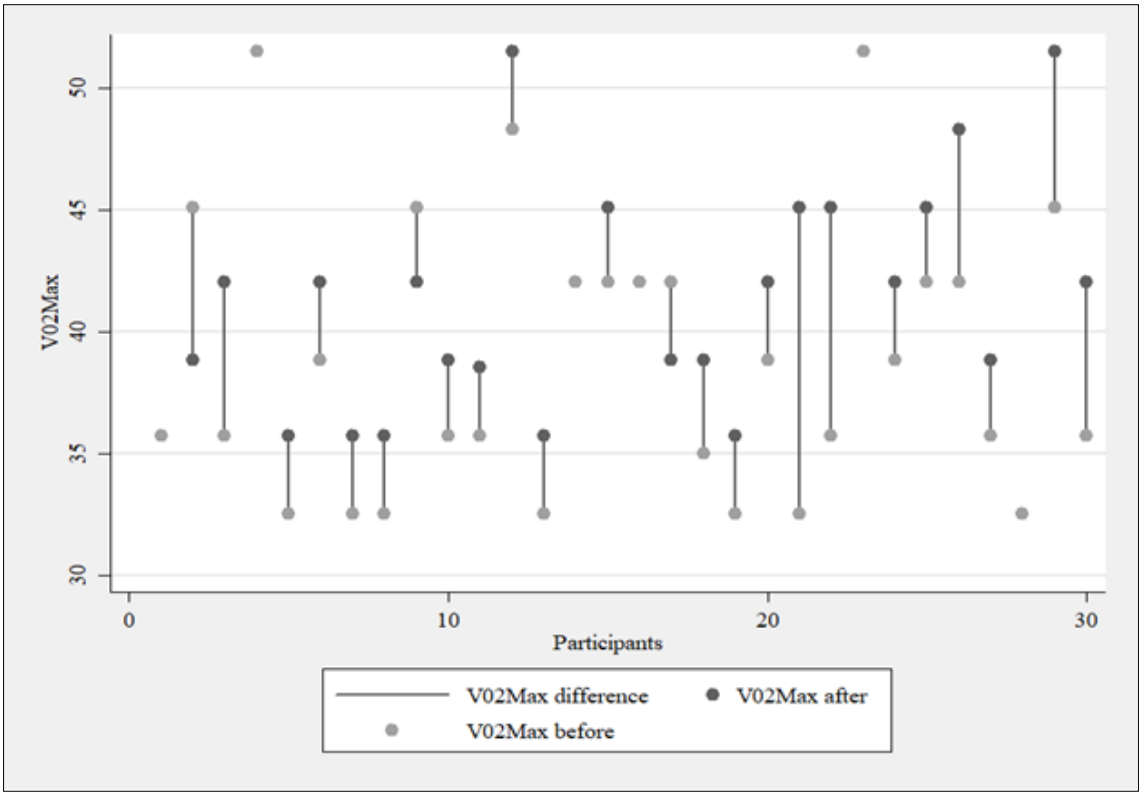

Fig 1: Distribution of the Shuttle run Scores by the Participants

From the study results, players performed more shuttle runs after the program with an average of (41.663±5.34199) $V0_2$ max as compared to before the program (38.9133±5.73102) $V0_2$ max. This showed a statistically significant increase of 2.75 t (29) =4.093, and effect size d = 0.741. The hypothesis that there would not be any significant increase in cardiovascular endurance was thus rejected.

4 Discussion

In the present study, the shuttle run test scores were in $V0_2$ max. The mean score for the participants before the training was at (38.9133±5.73102) $V0_2$ max, after the training, the mean went higher to (41.663±5.34199) $V0_2$ max. A statistically significant mean increase of 2.75 was recorded, SD = 3.6798 at 95% CI. In a study by Chamari, Imperilezzeri and Rampinini (2016) [7], Yoyo test endurance level 2 and yoyo test Intermittent level 1 were used on soccer players but to determine their physiological determinants of the test. The tests are crucial as they enable the strength and conditioning coaches to gauge the physical state of the athletes. These improvements show that an increase in cardiovascular training and the formal skill training bring about a positive change in the overall cardiovascular endurance of youth athletes. Due to its importance, cardiovascular fitness for a game should be assessed regularly to monitor and determine the players' preparedness (Castagna *et al*., 2017) [8]. To the best of our knowledge, this is the first study in Kenya with a specific focus on the impact of cardiovascular fitness training on high school soccer players.

Cardiovascular endurance mainly entails the ability of the body to work continuously for extended periods (Patil, O'Keefe, Lavie, Vogel, 2015) [9]. Cardiovascular endurance is considered an essential component of fitness as it gives the body stamina to generate energy and ensure the delivery of oxygen to working muscles (Patil *et al*., 2015) [9]. A soccer player should ideally be able to maintain the ability to play at a high level throughout their play session (Helgerud *et al*., 2001) [10]. Nonetheless, over time studies have shown a reduction in work intensity, distance covered, and reduced lactate and blood sugar levels during the second half period of games compared to the first half period. This ideally portrays the necessity for players to have good cardiovascular endurance in soccer and the need for its emphasis in training (Helgerud *et al*., 2002) [11]. Physiological adaptations occur in the body to ensure this takes place. Such adaptations include; enlarged left and right ventricle volumes, increased ventricular wall thickness, cardiac mass, and atrial size (Pellicia *et al*., 2014) [12].

Soccer relies on endurance training programs to build on cardiovascular endurance. Some trainers have embraced small-sided games to build on players' cardiovascular endurance (Imperilezzi *et al*., 2017) [8]. In another study by McMillan, Helgerud, Macdonald, and Hoff (2014) [13] soccer-specific endurance training was used to improve the cardiorespiratory capacity of the athletes. Eleven youth soccer players with a mean (SD) age of 16.9 (0.4) years performed high-intensity aerobic interval training sessions twice per week for 10 weeks in addition to regular soccer training. The specific aerobic training consisted of four sets of 4 min work periods dribbling a soccer ball around a specially designed track at 90–95% of maximal heart frequency, with a 3 min recovery jog at 70% of maximal heart frequency between intervals. There Mean $V0_2$max improved significantly from 63.4 (5.6) to 69.8 (6.6) ml kg^1 min^1.Workout routines in soccer require keen and intentional planning in order for it to be effective (Morgans, Patrick, Liam, and Barry, 2014) [14]. Attributes such as the intermittent and cyclical nature of soccer should be considered (McMillan *et al*., 2005) [15]. High-Intensity functional training has been proposed to optimize athletes' cardiovascular fitness (Roberto, Claudio, Michele, 2022) [16].

Several factors come into play when designing athletes' cardiovascular endurance programs. In their study of soccer-specific aerobic endurance training, Hoff, Wilsoff, Engen, Kemi, and Helgerud (2002) [17] planned for their soccer-specific endurance training in small group play units and on dribbling tracks. However, the training was intense to effectively impact the athletes $V0_2$ Max and their soccer performance. In a study conducted in Norway, athletes went through a training protocol that entailed interval training at an intensity of 90-95%, four times, four minutes each. The periods were separated by 3 mins of jogging. Furthermore, the intervention was administered as an extension of regular training per week, and it was done twice over eight weeks (Helgerud *et al*., 2001) [10]. In this program, no strength training was however performed. At the end of the program, the players recorded an overall increase in VO_2 max. This was portrayed by an overall increase in the number of sprints. The cumulative distance covered in a game also increased from 8619 (1237) m pre-training to 10335 (1608) m post-training. The difference between the present study and Helgerud *et al*. (2014) [18] study was that strength training was excluded. The lack of strength training may have had a more positive or negative effect on the outcome.

In the United Kingdom, a study was done on the endurance of young athletes and how it can be trained (Maffulli, 1991) [19]. It was found that engaging youth athletes in endurance exercises greatly enhance their tolerance for exercise (Maffulli, 1991) [19]. The study also found that endurance training improves athletes' $V0_2$ and anaerobic threshold. Thus, this generally improved the athletes' overall performance (Maffulli, 1991) [19]. Concurrent training involving engaging in strength training and endurance training has been found to improve attributes such as the lower body power of an athlete (Gabler *et al*., 2018) [20]. Furthermore, physiological traits associated with cardiovascular endurance that one develops during their youthful years tend to be carried on into their adulthood (Eduard & Mont, 2019) [21]. It is also noted that cardiovascular endurance training in youth soccer has evolved and it should be carried out in a more sports-specific way (Hoff, 2002) [17]. Specially designed dribbling tracks can be used, and small playing groups can be created. All this will be done to produce the work intensity that the trainer wants (Hoff, 2002) [17].Nevertheless, most of the studies that have been done in Africa on cardiovascular endurance in soccer players have inclined mostly towards elite athletes. One study done on university students who engage in soccer in a university in Ghana observed the need for programs to be designed with regard to the duration and intensity of the workout (Francis *et al*., 2020) [22]. This was to ensure that the athletes benefit from the workout (Francis *et al*., 2020, Avijit *et al*., 2019) [22, 23].

5. Conclusion

Most of the studies (Helgerud *et al*., 2001[1]; Hoff, Wilsoff, Engen, Kemi, Helgerud, 2002 [11]; Daniel, 2019 [4]; Eske, 2019 [5]; Maffulli, 1991[19]; Gabler *et al*., 2018 [20]; Eduard & Mont, 2019 [21]; Hoff, 2002 [17]; Francis *et al*., 2020 [22]) create a concrete foundation for the need of cardiovascular training in soccer. However, the focus of most of the studies has been

on elite soccer players. Nonetheless, more studies have to be done focusing on cardiovascular endurance training in youth athletes, especially in Africa. The current study creates more data that can be used for further research. Based on the results of this study, a tailor-made high intensity functional 8-week cardiovascular fitness practice for youth soccer athletes can improve their cardiovascular endurance of athletes.

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