IMPACT OF AEROBIC AND ANAEROBIC FITNESS ON PHYSICAL FITNESS OF FEMALE ATHLETES

ABSTRACT

Success in sports and many other group activities requires a total feeling of well-being as well as specialized and strategic skills in individual and team activities. One of the fundamental characteristics that influence athletic performance is viewed as PF. The main objective of this study was to analyze the impact of aerobic and anaerobic systems on PF of female athletes. This paper is a part of doctoral thesis and one of the objectives of this thesis was “to analyze the impact of aerobic and anaerobic fitness on the PF of female athletes”. The study used an experimental design with pre and post-test. Only female players of basketball and netball participated from two different universities namely “Lahore College Women University (LCWU)’ and “The University of the Punjab (PU)” from Lahore, Pakistan. Stratified random sampling method was used to collect data. In addition to demographic data, detailed information on health status was also collected through “Student-Athlete Health History Questionnaire” as part of the inclusion criteria. An equal number of participants were assigned to the control group (n=52) and the experimental group (n=52). . The training program started with a pre-test and the training was implemented three times a week for 8 weeks under the direct supervision of trained instructors at LCWU and PU on alternate days. The score of each training session was recorded for each participant in all the fitness tests, and a post-test was performed at the end of the training. Scores of the 20-meter shuttle run test were used to measure aerobic fitness. Mean scores agility and speed tests were used to measure anaerobic fitness. Mean scores of all the tests were computed to generate scores for PF. Mean comparisons were performed under descriptive analysis and Paired Sample t-test and Univariate Analysis of Variance was performed for hypothesis testing. Paired Sample t-test for all three fitness variables showed “a significant difference for aerobic fitness from pretest to posttest as t (207) = 0.89, p = 0.000 and a significant difference for anaerobic fitness was also found as t (207) =110, p = 0.000 and similarly, a significant difference for PF from pretest to posttest was found as t (207) = 95, p=0.000.” A significant impact of aerobic fitness on PF was found (F=3.08, p=0.000) and a significant impact of anaerobic fitness on PF was also found (F=2.36, p=0.005). The results of the study concluded that aerobic and anaerobic fitness showed significant improvement in PF of female athletes. Aerobic fitness showed significant effect on CRF, muscular strength, muscular endurance, flexibility and agility of the participants with no significant effect on BMI and anaerobic fitness showed significant effect on muscular strength and speed only.

Key words: *Aerobic, Anaerobic, PF, 20 M Shuttle Run Test, Speed, Agility, Power, Strength*

Introduction

Success in sports and many other group activities requires a total feeling of well-being as well as specialized and strategic skills in individual and team activities. One of the fundamental characteristics that influence athletic performance is viewed as PF (PF), which should be the main variable [1]. Normally PF is characterized as the "capacity to perform everyday movements with essentialness and sharpness, without unnecessary weakness, having the option to see the value in light of a reasonable concern for relaxation time and adapt to unanticipated crises"[2]. It is the blend of wellbeing and ability related components of PF that should be basic in forming individuals in sports. It is worth noting that basketball and netball are two cutthroat games, which require a great level of PF for an effective execution of the specialized and strategic abilities to improve sports performance.

The wellbeing related components of PF are “body composition (BMI), cardiorespiratory fitness (CRF), flexibility, muscular strength, and muscular endurance” [3]. Similarly as with most group activities, there are a different PF components that are essential to improve in basketball and netball which incorporate speed and agility [34], however aerobic and anaerobic systems are also very important. Having an excellent degree of high-impact anaerobic training, which is vital and being exceptionally quick in terms of speed and lithe in terms of agility are also important [3]. Players’ position likewise influences the overall significance of these areas of PF.

The shuttle run test (20m SRT) would usually be the most appropriate test for testing VO2 max for basketball or netball teams. There are many other aerobic fitness tests which are also suitable as indicated in a number of studies that have supported the correlation between running performance and directly measured VO2 max in adolescents [4]. The most grounded connections happen when the standard run distance is around 1600-2400 meter, or for coordinated runs when the standard test time is around 9-15 min [5]. Besides, unique distance run tests force different physiological and psychosocial requests for instance, factors like VO2 max and anaerobic limit are becoming generally more significant for more limited distance runs [6].

Distance run performance improves as children grow up. Analysis of data cumulated across 10 studies shows that between the ages of seven and 16 years, there's an age-related improvement of 35% and 21% in 1600-m run performance of boys and girls, respectively [7]. Boys' performance continues to enhance until about the age of 15 years whereas girls' performance stabilizes around the age of 13 years [8]. But the explanations behind age-related performance improvement are unclear. Examination of age-related changes in factors which underscore distance run performance may provide some clues. While VO2 max explains a moderate to a large proportion of distance running performance by cross-sectional studies little insight compared to longitudinal studies [8].

The reviews [8, 13] indicated that as children grow, mass-specific VO2 max remains relatively stable in boys and declines by about 30% in girls [9]. On the opposite hand, cross-sectional and longitudinal studies examining the level of running efficiency in children indicated that older children were more efficient than the younger ones. This suggests that older children can perform longer at an equivalent speed, or faster over an equivalent distance. Another answer may roll in the hay fractional utilization. It was also reported that the 9-min running performances of older children were partly explained by their better ability to sustain a better fraction of VO2 max [15].

Sprint running tests ranging from 20 to 100 m have been described, with 30–50-m sprints the most commonly used to measure anaerobic fitness [10]. Generally, sprint running tests can not only be performed outdoors on a grass field or a running track but can also be performed indoors, provided there is sufficient room for the sprint run and post-run [11]. It is common for the sprint run to be performed only once, using a standing start, with the time taken recorded.

Literature Review

Basketball is primarily characterized by anaerobic features, with elite players often being subject to more than 2,700 characteristic actions intermittently, including walking, running, sprinting, and jumping [12]. From the point of view of high-intensity work, many time-motion studies, it has been reported that approximately 50 actions are sprints [10, 11]. It was also noted that [13] sprints are considered to be one of the most important tasks for athletes. Observing the intermittent efforts in basketball, the endurance of strength is an essential component of sports fitness, as the ability to maintain the greatest strength during various endeavors is crucial in the decisive moments of the game. The ability to perform continuous sprint endeavors is called repetitive sprint activity and is characterized by short heights and short recovery periods [14, 16], and in general, it is used as an important parameter of athletic performance in relation to resistance for fatigue.

According to a few researchers [16, 17], this ability to perform repeated high-intensity efforts strongly correlates with the performance of phosphatidylserine recovery rate and hydrogen from muscle during the recovery period and it is about removing Hydrogen ions concentration, which are associated with muscle fatigue [18]. Netball is viewed as one of the quick group activities that require a mix of aerobic (moderate intensity) and anaerobic (high impact) fitness to play out [19]. The group needs to place a ton of accentuation on running and jumping. Aerobic capacity, speed, balance, adaptability, and tossing address proactive tasks that are viewed as significant parts of the game and add to the group's superior presentation [20]. The main parts of the ball control are passing and getting. An aggressive approach rotates around the capacity of a group to move the ball rapidly and precisely from one player to the next one. Although it’s hard to determine the time spent in different movements in netball due to inconsistencies between methods used in different studies [21]. A few researchers reported [22, 23] moderate intensity activities such as standing and walking as the most frequently occurring activities in netball [24].

High intensity actions, such as sprinting with or without the ball, jumps, stops, changes of direction and duels are less frequently occurring but crucial nonetheless because of the involvement of these movements during decisive parts of the game [25]. High intensity runs can contribute to approximately 8 % of total playing time or 1.7 % of total distance covered [26].

Materials and Methods

This paper is a part of doctoral thesis and one of the objectives of this thesis was “to analyze the impact of aerobic and anaerobic fitness on the PF of female athletes”. The study used an experimental design with pre and post-test randomized group design. Only female players of basketball and netball participated from two different universities namely “Lahore College Women University (LCWU)’ and “The University of the Punjab (PU)” from Lahore, Pakistan. Stratified random sampling method was used to collect data. In addition to demographic data, detailed information on health status was also collected through Student-Athlete Health History Questionnaire developed by Alvin Community College [33]. This information was collected as part of the inclusion criteria. An equal number of participants were assigned to the control group (n=52) and the experimental group (n=52). . The training program started with a pre-test and the training was implemented three times a week for 8 weeks under the direct supervision of trained instructors at LCWU and PU on alternate days (Annex-1). The score of each training session was recorded for each participant in all the FFT, and a post-test was performed at the end of the training. Scores of the 20-MST were used to measure aerobic fitness. Mean scores of agility and speed tests were used to measure anaerobic fitness. Mean scores of all the tests were computed to generate scores for PF. Mean comparisons were performed under descriptive analysis. Paired Sample t-test and a Univariate Analysis of Variance was performed for the hypothesis testing at the 0.05 level for the following null hypotheses:

1. There will be no significant differences in PF of female athletes from pre-to post-test
2. There will be significant impact of aerobic and anaerobic systems on PF of female athletes

Results

Mean comparisons were made for different variables including age in years for control group (M=20.86, SD=1.42), and experimental group (M=20.92, SD=1.46); height in cm for control group (M=164.19, SD=9.04), and experimental group (M=164.19, SD=9.04); weight in KGs for control group (M=54.55.86, SD=.67), and experimental group ((M=54.55, SD=.67). Paired Sample t-test for all three fitness variables. “A significant difference for aerobic fitness from pretest to posttest was found as t (207) = 0.89, p = 0.000 and a significant difference for anaerobic fitness was also found as t (207) =110, p = 0.000 and similarly, a significant difference for PF from pretest to posttest was found as t (207) =95, p=0.000.” A significant impact of aerobic fitness on PF was found (F=3.08, p=0.000) and a significant impact of anaerobic fitness on PF was also found (F=2.36, p=0.005). Thus, null hypotheses of this study were rejected.

Table-1

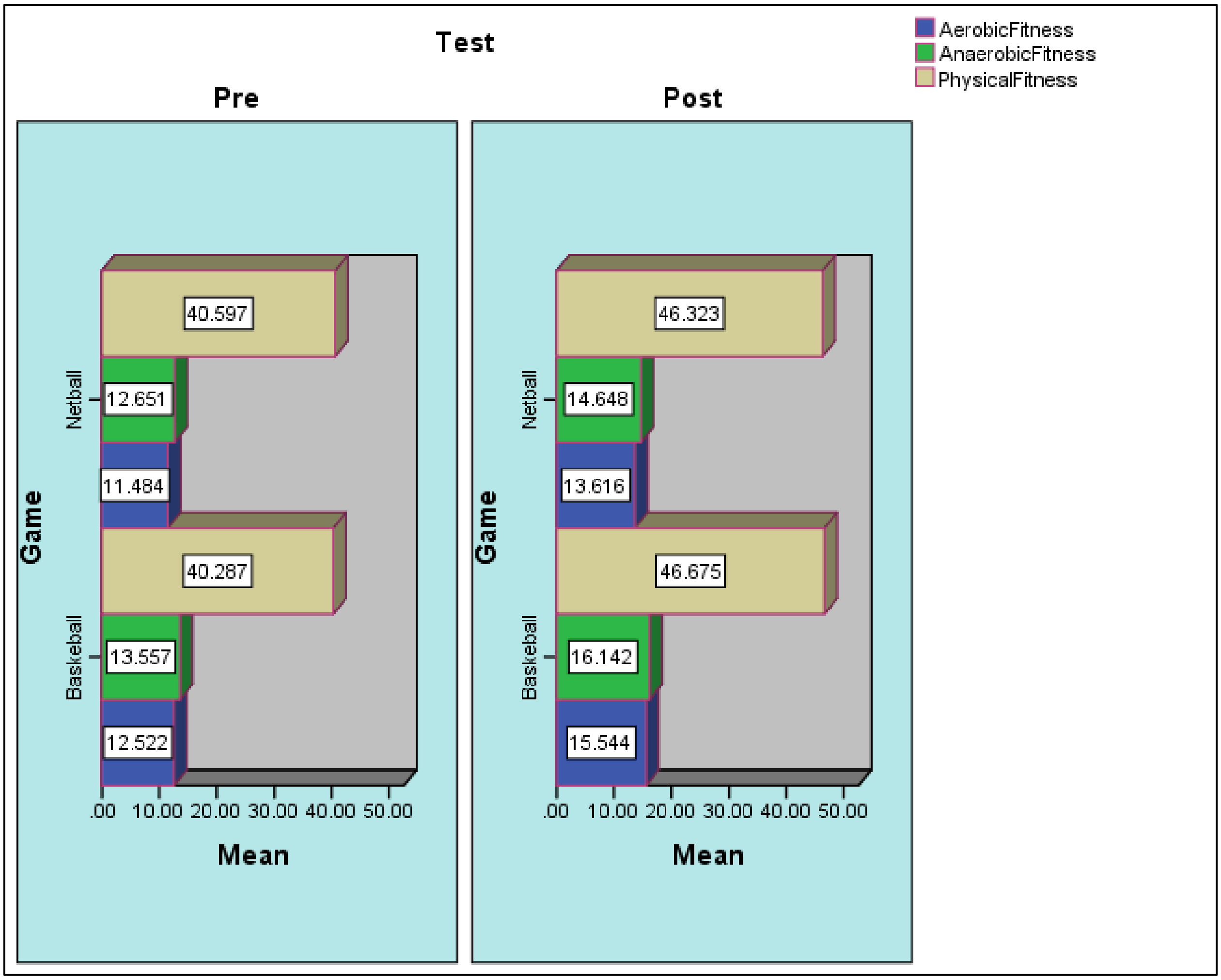
Comparisons between Pre-Test and Post

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Test – Aerobic Fitness	-11.79178	1.90085	.13180	-12.05162	-11.53194	.89.467	207	.000
Pair 2	Test – Anaerobic Fitness	-12.74957	1.66677	.11557	-12.97741	-12.52172	-110.319	207	.000
Pair 3	Test – PF	-41.97040	6.34383	.43987	-42.83759	-41.10321	95.416	207	.000

Table-1 is showing the results of Paired Sample t-test for all three fitness variables. "A significant difference for aerobic fitness from pretest to posttest was found as t (207) = 0.89, p = 0.000 and a significant difference for anaerobic fitness was also found as t (207) =110, p = 0.000 and similarly, a significant difference for PF from pretest to posttest was found as t (207) =95, p=0.000." All these results are significant at the 0.05 level.

Figure-1

Comparison of Pre and Posttest of Basketball and Netball



A comparisons of mean scores for pre and posttest for basketball and netball players are shown in Figure-1, which indicate an increase for basketball players on aerobic fitness from pretest (M=12.52) to posttest (M=15.54); on anaerobic fitness from pretest (M=13.55) to posttest (M=16.14); on PF from pretest (M=40.28) to posttest (M=46.67) and for netball players on aerobic fitness from pretest (M=11.48) to posttest (M=13.61); on anaerobic fitness from pretest (M=12.65) to posttest (M=14.64); on PF from pretest (M=40.59) to posttest (M=46.32).

Table-2

Impact of Aerobic and Anaerobic Fitness on PF of Female Athletes

Source	Type III Sum of Squares	df	Mean Square	F	Sig.

Corrected Model	7497.891[a]	131	57.236	3.084	.000
Aerobic Fitness	2279.362	52	43.834	2.362	.000
Anaerobic Fitness	1815.047	51	35.589	1.918	.005
Total	401960.949	208			
Corrected Total	8908.438	207			

A significant impact of aerobic fitness on PF was found (F=3.08, p=0.000) and a significant impact of anaerobic fitness on PF was also found (F=2.36, p=0.005) as shown in Table-2.

Discussion

The exercise practice provided change in the regular PA and practicing exercises in a structured environments provides countless benefits to physical and mental health [27]. He states that students who engage in regular PA are less likely to get into negative lifestyle and present positive results related to PF. Hence, engaging in group level training may promote the adherence to the PA practice and lifestyle changes, consequently preventing diseases associated with inactivity. It was observed in the current study that the regular PA practice increased overall PF in female athletes. Therefore, a structured training plan may be applied as a non-pharmacological way to improve strength and increase power, which results in lowered level of BMI [28].

Before the intervention, the participants were assessed according to their PF level for cardiorespiratory capacity (M=1.02), muscular strength (M=1.53), flexibility (M=9.89), speed (M=1.02) and agility (M=12.70). After training, there was an increase in the PF related components as CRF (M=1.09), muscular strength (M=2.07), flexibility (M=12.68), speed (M=1.16) and agility (M=13.64). The improvement in PF and CRF levels was resulted as a combined effect of aerobic and anaerobic fitness levels. Paired sample t-test indicated significant improvement from pre-test to post-test in PF of female athletes (p=0.000). Whereas, univariate analysis of variance revealed significant effect of aerobic (p=0.000) and anaerobic fitness (p=0.005) on PF (computed as average score of seven fitness tests).

In view of these findings, the training program was seen to cause an improvement in the PF level of female athletes. It was observed that moderate intensity aerobic training caused a significant improvement in VO2 max (p=0.000). Numerous different examinations show that aerobic definitively affects vigorous limit, and the activity time of these investigations are accounted for to be somewhere in the range of six to eight weeks to be effective [4, 29]. One more investigation of comparative nature [30] reports the advantages of high and low power span practices carried on for a long time have an impact on VO2 max levels through persistent activity [30].

One more outcome from the training program is that, following the activity period there exists no changes in BMI (p=1.000). Previous studies showed that persistent and stretch activities led for three days per week for a considerable length of time span practices having no effect on BMI [31]. In this research also, anaerobic fitness showed no effect on BMI. Another study of comparative nature, tracked down an increment of 16% measurably applicable and significant VO2 max levels, following a ten-week practice with broad stretch technique [4, 9]. In present study, since the time frame of this training was restricted to about two months, it was noticed that high-impact anaerobic training was limited. In accordance with these outcomes, it is possible that high-impact limit can be expanded with vigorous activity strategy through a lengthy/long activity program. Notwithstanding, present study showed no reduction in BMI conversely, of the other review. This disparity might have been brought about by the usage of the treadmill work out, which utilizes more muscle groups [3, 23] whereas, the present study was limited to field tests only.

As per one more outcome got from present research (Annex-2), it was seen that aerobic training significantly affected CRF (p=0.001), muscular strength (p=0.000), speed (p=0.000), agility (p=0.000) and muscular endurance (p=0.000). Another study indicated that aerobic training is a good indicator of fitness components and excellent predator of CRF [4, 9]. As far as anaerobic training is concerned, it showed significant effect on muscular strength (p=0.025) and speed (p=0.018), while having no significant effect on other fitness related components and these results are not in line with other studies as anaerobic fitness has greater impact on speed and agility [6]. However, it is possible that the frequency and intensity and duration of the training can affect other components of PF of female athletes.

Conclusion

The results of the study concluded that aerobic and anaerobic fitness showed significant improvement in PF of female athletes. Aerobic fitness showed significant effect on CRF, muscular strength, muscular endurance, flexibility and agility of the participants with no significant effect on BMI and anaerobic fitness showed significant effect on muscular strength and speed only.

References

1. Argiriou M. The Role of Preceding Technical and Tactical Skills on Jump Shot Accuracy in Male and Female Basketball Players. Journal of Athletic Enhancement [Internet]. 2014 [cited 2022 Mar 22];03(04). Available from: https://doi.org/10.4172/2324-9080.1000157
2. Gamble P. A Skill-Based Conditioning Games Approach to Metabolic Conditioning for Elite Rugby Football Players. Journal of Strength and Conditioning Research [Internet]. 2004 Aug [cited 2022 Mar 23];18(3):491-7. Available from: https://doi.org/10.1519/00124278-200408000-00017
3. Sinclair C, Coetzee FF, Schall R. Physical and physiological profile of U18, U19, U21 and senior elite netball players. South African Journal of Sports Medicine [Internet]. 2020 Feb 13 [cited 2022 Mar 23];32(1):1-7. Available from: https://doi.org/10.17159/2078-516x/2020/v32i1a6545
4. Aandstad A, Holme I, Berntsen S, Anderssen SA. Validity and Reliability of the 20 Meter Shuttle Run Test in Military Personnel. Military Medicine [Internet]. 2011 May [cited 2022 Mar 22];176(5):513-8. Available from: https://doi.org/10.7205/milmed-d-10-00373
5. Bagavinar K and Kamalakkannan K. Effect of Aerobic Training, aquatic training and combined training on selected physical fitness variables among obese College Men, Indian Journal of Applied Research. 2013, 3.
6. Häkkinen K. Changes in physical fitness profile in female volleyball players during the competitive season. Department of Biology of Physical Activity, University of Jyväskylä, Finland. J Sports Med Phys Fitness 1993;33 (3):223-32.
7. Philippaerts RM, Vaeyens R, Janssens M, Van Renterghem B, Matthys D, Craen R, Bourgois J, Vrijens J, Beunen G, Malina RM. The relationship between peak height velocity and physical performance in youth soccer players. Journal of Sports Sciences

[Internet]. 2006 Mar [cited 2022 Mar 23];24(3):221-30. Available from: https://doi.org/10.1080/02640410500189371

8. Grivas G. Physiological predictors of distance runners' performance: a narrative review. TRENDS in Sport Sciences. 2020:117-23.
9. Barr R, Clark CC, Corbett J, Draper SB. Artefactual incidence ofV˙O2plateau andV˙O2maxin historical studies. Science & Sports [Internet]. 2018 Jun [cited 2022 Mar 23];33(3):e129-e132. Available from: https://doi.org/10.1016/j.scispo.2018.01.004
10. Haugen T, Seiler S, Sandbakk Ø, Tønnessen E. The Training and Development of Elite Sprint Performance: an Integration of Scientific and Best Practice Literature. Sports Medicine - Open [Internet]. 2019 Nov 21 [cited 2022 Mar 23];5(1). Available from: https://doi.org/10.1186/s40798-019-
11. Verschuren O, Takken T. The Muscle Power Sprint Test. Journal of Physiotherapy [Internet]. 2014 Dec [cited 2022 Mar 23];60(4):239. Available from: https://doi.org/10.1016/j.jphys.2014.08.001
12. Argiriou M. The Role of Preceding Technical and Tactical Skills on Jump Shot Accuracy in Male and Female Basketball Players. Journal of Athletic Enhancement [Internet]. 2014 [cited 2022 Mar 23];03(04). Available from: https://doi.org/10.4172/2324-9080.1000157
13. Buchan DS, Knox G, Jones AM, Tomkinson GR, Baker JS. Utility of international normative 20 m shuttle run values for identifying youth at increased cardiometabolic risk. Journal of Sports Sciences [Internet]. 2018 Aug 16 [cited 2022 Mar 23];37(5):507-14. Available from: https://doi.org/10.1080/02640414.2018.1511318
14. Tottori N, Fujita S. Effects of Plyometric Training on Sprint Running Performance in Boys Aged 9–12 Years. Sports [Internet]. 2019 Oct 10 [cited 2022 Mar 23];7(10):219. Available from: https://doi.org/10.3390/sports7100219
15. Joyner MJ. Modeling: optimal marathon performance on the basis of physiological factors. Journal of Applied Physiology [Internet]. 1991 Feb 1 [cited 2022 Mar 23];70(2):683-7. Available from: https://doi.org/10.1152/jappl.1991.70.2.683
16. Antero-Jacquemin J, Pohar-Perme M, Rey G, Toussaint JF, Latouche A. The heart of the matter: years-saved from cardiovascular and cancer deaths in an elite athlete cohort with over a century of follow-up. European Journal of Epidemiology [Internet]. 2018 May 5

[cited 2022 Mar 22];33(6):531-43. Available from: https://doi.org/10.1007/s10654-018-0401-0

17. Gil SM, Zabala-Lili J, Bidaurrazaga-Letona I, Aduna B, Lekue JA, Santos-Concejero J, Granados C. Talent identification and selection process of outfield players and goalkeepers in a professional soccer club. Journal of sports sciences. 2014 Dec 14;32(20):1931-9.Available from: https://doi.org10.1080/02640414.2014.964290
18. Tieland M, Trouwborst I, Clark BC. Skeletal muscle performance and ageing. Journal of Cachexia, Sarcopenia and Muscle [Internet]. 2017 Nov 19 [cited 2022 Mar 23];9(1):3-19. Available from: https://doi.org/10.1002/jcsm.12238
19. Ben Abdelkrim N, Castagna C, El Fazaa S, El Ati J. The Effect of Players' Standard and Tactical Strategy on Game Demands in Men's Basketball. Journal of Strength and Conditioning Research [Internet]. 2010 Oct [cited 2022 Mar 23];24(10):2652-62. Available from: https://doi.org/10.1519/jsc.0b013e3181e2e0a3
20. Healy R, Norris M, Kenny IC, Harrison AJ. A Novel Protocol to Measure Short Sprint Performance. Procedia Engineering [Internet]. 2016 [cited 2022 Mar 23];147:706-11. Available from: https://doi.org/10.1016/j.proeng.2016.06.252
21. Doncaster G, Unnithan V. Between-Game Variation of Physical Performance Measures in Highly Trained Youth Soccer Players. Journal of Strength and Conditioning Research [Internet]. 2019 Jul [cited 2022 Mar 23];33(7):1912-20. Available from: https://doi.org/10.1519/jsc.0000000000002132
22. Althoff T, Sosič R, Hicks JL, King AC, Delp SL, Leskovec J. Large-scale physical activity data reveal worldwide activity inequality. Nature [Internet]. 2017 Jul [cited 2022 Mar 22];547(7663):336-9. Available from: https://doi.org/10.1038/nature23018
23. Edholm P, Krustrup P, Randers MB. Half-time re-warm up increases performance capacity in male elite soccer players. Scandinavian Journal of Medicine & Science in Sports [Internet]. 2014 Apr 30 [cited 2022 Mar 23];25(1):e40-e49. Available from: https://doi.org/10.1111/sms.12236
24. Krolo A, Gilic B, Foretic N, Pojskic H, Hammami R, Spasic M, Uljevic O, Versic S, Sekulic D. Agility Testing in Youth Football (Soccer)Players; Evaluating Reliability, Validity, and Correlates of Newly Developed Testing Protocols. International Journal of

Environmental Research and Public Health [Internet]. 2020 Jan 1 [cited 2022 Mar 23];17(1):294. Available from: https://doi.org/10.3390/ijerph17010294

25. Neykov S, Bachev V, Petrov L, Alexandrova A, Andonov S, Kolimechkov S. Application of hypoxicators in the rowers' training. Pedagogics, psychology, medical-biological problems of physical training and sports [Internet]. 2019 Sep 17 [cited 2022 Mar 23]; 23(5):239-45. Available from: https://doi.org/10.15561/18189172.2019.0505
26. Thomas, Christopher & Comfort, Paul & Jones, Paul & Dos'Santos, Thomas. Strength and Conditioning for Netball: A Needs Analysis and Training Recommendations [Internet]. 2017 [cited 2022 Mar 23]; Strength and conditioning journal. 39. 10.1519/SSC.0000000000000287.
27. Limmer M, Eibl AD, Platen P. Enhanced 400-m sprint performance in moderately trained participants by a 4-day alkalizing diet: a counterbalanced, randomized controlled trial. Journal of the International Society of Sports Nutrition [Internet]. 2018 May 31 [cited 2022 Mar 23];15(1). Available from: https://doi.org/10.1186/s12970-018-0231-1
28. Jensen B, Braun W, Geisler C, Both M, Klückmann K, Müller MJ, Bosy-Westphal A. Limitations of Fat-Free Mass for the Assessment of Muscle Mass in Obesity. Obesity Facts [Internet]. 2019 [cited 2022 Mar 23];12(3):307-15. Available from: https://doi.org/10.1159/000499607
29. Krolo, A., Gilic, B., Foretic, N., Pojskic, H., Hammami, R., Spasic, M., Uljevic, O., Versic, S. and Sekulic, D. Breakthrough Basketball - Hundreds of FREE Basketball Coaching Drills, Plays, Tips, Offenses, Defenses & Resources [Internet]. [cited 2022 Mar 23]. Available from: https://www.breakthroughbasketball.com/cr/BasketballDevGuideforParents.pdf
30. Alricsson M, Harms-Ringdahl K, Werner S. Reliability of sports related functional tests with emphasis on speed and agility in young athletes. Scandinavian Journal of Medicine & Science in Sports [Internet]. 2001 Aug [cited 2022 Mar 23];11(4):229-32. Available from: https://doi.org/10.1034/j.1600-0838.2001.110406.x
31. Delextrat A, Cohen D. Physiological Testing of Basketball Players: Toward a Standard Evaluation of Anaerobic Fitness. Journal of Strength and Conditioning Research [Internet]. 2008 Jul [cited 2022 Mar 23];22(4):1066-72. Available from: https://doi.org/10.1519/jsc.0b013e3181739d9b

32. Larsen LR, Kristensen pl, Junge t, Rexen ct, Wedderkopp n. Motor Performance as Predictor of Physical Activity in Children. Medicine & Science in Sports & Exercise [Internet]. 2015 Sep [cited 2022 Mar 23];47(9):1849-56. Available from: https://doi.org/10.1249/mss.0000000000000604
33. Student-Athlete Health History Questionnaire Student-Athlete Health History Questionnaire. (2013). Available from: https://www.alvincollege.edu/athletics/pdf/health-history-questionnaire.pdf
34. Zemková, Erika & Hamar, Dusan. Agility performance in athletes of different sport specializations [Internet]. 2014 Acta Gymnica. 44. 133-140. Available from: http://doi.org10.5507/ag.2014.013

Annex-1

8-Weeks Aerobic & Anaerobic Fitness Training (Agility, Strength, Power, Speed, and Flexibility)

Source: Kritz & Thompson, 2010

Week	Field Fitness Tests
Pre-Test	Structured warm-up of about 10 min (run & jog), The 20m shuttle run, The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
Week-1 (Monday)	Structured warm-up of about 10 min (run & jog), The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Wednesday)	Structured warm-up of about 10 min, The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Friday)	Structured warm-up of about 10 min, The 20m shuttle run, Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
Week-2 (Monday)	Structured warm-up of about 10 min, The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Wednesday)	Structured warm-up of about 10 min, The 20m shuttle run, Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Friday)	Structured warm-up of about 10 min, The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
Week-3 (Monday)	Structured warm-up of about 10 min, The 20m shuttle run, Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Wednesday)	Structured warm-up of about 10 min, The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Friday)	Structured warm-up of about 10 min, The 20m shuttle run, Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
Week-4 (Monday)	Structured warm-up of about 10 min, The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Wednesday)	Structured warm-up of about 10 min, The 20m shuttle run, Sprint Fatigue Test-10 x

	30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Friday)	Structured warm-up of about 10 min, The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
Week-5 (Monday)	Structured warm-up of about 10 min, The 20m shuttle run, Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Wednesday)	Structured warm-up of about 10 min, The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Friday)	Structured warm-up of about 10 min, The 20m shuttle run, Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
Week-6 (Monday)	Structured warm-up of about 10 min, The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Wednesday)	Structured warm-up of about 10 min, The 20m shuttle run, Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Friday)	Structured warm-up of about 10 min, The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
Week-7 (Monday)	Structured warm-up of about 10 min, The 20m shuttle run, Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Wednesday)	Structured warm-up of about 10 min, The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Friday)	Structured warm-up of about 10 min, The 20m shuttle run, Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
Week-8 (Monday)	Structured warm-up of about 10 min, The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Wednesday)	Structured warm-up of about 10 min, The 20m shuttle run, Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
(Friday)	Structured warm-up of about 10 min, The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints, starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).
Post-Test	Structured warm-up of about 10 min, The 20m shuttle run, The four cones T-test (20-Yards), The four cones T-test (20-Yards), Sprint Fatigue Test-10 x 30m sprints,

	starting every 30 seconds, Plank (3 Reps), Sit & Reach Test (3 Reps), Cooling down (2 min).

Annex-2

GLM-Multivariate Analysis of Variance

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	CRE	591.189[a]	131	4.513	2.747	.000
	MuscularStr	454.425[b]	131	3.469	3.198	.000
	Flexibility	2223.113[c]	131	16.970	2.325	.000
	Speed	11245.201[d]	131	85.841	3.262	.000
	Agility	2193.004[e]	131	16.740	2.343	.000
	MuscularEnd	9618.765[f]	131	73.426	1.968	.001
	VO2MAX	6065.771[g]	131	46.304	3.296	.000
	BMI	1301.778[h]	131	9.937	.773	.902
Intercept	CRE	8403.256	1	8403.256	5114.493	.000
	MuscularStr	266.573	1	266.573	245.738	.000
	Flexibility	12074.240	1	12074.240	1653.977	.000
	Speed	16002.763	1	16002.763	608.050	.000
	Agility	12070.013	1	12070.013	1689.431	.000
	MuscularEnd	93561.179	1	93561.179	2507.141	.000
	VO2MAX	104978.798	1	104978.798	7472.164	.000
	BMI	32461.645	1	32461.645	2525.236	.000
Aerobic Fitness	CRE	181.707	52	3.494	2.127	.001
	MuscularStr	141.322	52	2.718	2.505	.000
	Flexibility	719.292	52	13.833	1.895	.005
	Speed	3399.767	52	65.380	2.484	.000
	Agility	693.365	52	13.334	1.866	.006
	MuscularEnd	2962.415	52	56.970	1.527	.046
	VO2MAX	1937.391	52	37.258	2.652	.000
	BMI	266.596	52	5.127	.399	1.000
Anaerobic Fitness	CRE	123.018	51	2.412	1.468	.064
	MuscularStr	90.485	51	1.774	1.636	.025
	Flexibility	435.659	51	8.542	1.170	.264
	Speed	2282.083	51	44.747	1.700	.018
	Agility	419.184	51	8.219	1.150	.286
	MuscularEnd	2154.414	51	42.243	1.132	.308

	VO2MAX	1375.092	51	26.963	1.919	.005
	BMI	690.678	51	13.543	1.054	.413
Total	CRE	22885.487	208			
	MuscularStr	1372.312	208			
	Flexibility	35378.000	208			
	Speed	59340.060	208			
	Agility	35286.000	208			
	MuscularEnd	263350.000	208			
	VO2MAX	281184.000	208			
	BMI	86522.000	208			

a. R Squared = .826 (Adjusted R Squared = .525)

b. R Squared = .846 (Adjusted R Squared = .582)

c. R Squared = .800 (Adjusted R Squared = .456)

d. R Squared = .849 (Adjusted R Squared = .589)

e. R Squared = .802 (Adjusted R Squared = .459)

f. R Squared = .772 (Adjusted R Squared = .380)

g. R Squared = .850 (Adjusted R Squared = .592)

h. R Squared = .571 (Adjusted R Squared = -.168)