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Ethiopian Elite Female Long-Distance Runners' Some Physical and Physiological Characteristics

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Abstract

This research included 11 female professional Ethiopian elite distance athletes ranging in age from 21 to 37 years old, who run at Olympic Games, World Champions as well as in the platinum and gold label status road races. According to the WA labeling system, among the 11 samples of the runners 63.63% (7/11)) are platinum, and 36.37(4/11 are Gold Label Status runners. For a long time, Ethiopian athletes have dominated long-distance races across the world. The goal of this research was to learn about some of the physical and physiological features of elite Ethiopian female long-distance runners. Each athlete's height, weight, BMI, body composition, fat percentage (percentage of body weight), VO2 max, cooper test, exercise and resting heart rate, skinfold thickness, and blood pressure were all recorded and tabulated on the table. According to my research, living and training at high altitude, high-intensity training type, Vo2 max, running economy, low BMI, lower skinfold thickness, lower body fat percentage, and ectomorphic body composition make Ethiopian athletes so good. The VO2max of Ethiopian elite women long-distance runners competing at the international level ranges from72.6 to 81.9 ml/kg/min. The 12-minute running test (Cooper test), covers an incredible distance, ranging from 3750 m to 4200 m for women.

Keywords: Long-distance running; Ethiopians; VO2 max; world athletics

1. INTRODUCTION

In 1960, Abebe Bikila, 28 years old and unheralded, stunned the world by winning the Olympic marathon in the Rome Summer Olympic Games. He drew international notice not just for becoming the first African to win an Olympic gold medal, but also for running the race barefoot. He won his second gold medal at the 1964 Tokyo Olympics. He was the first athlete to successfully defend an Olympic marathon title after winning back-to-back Olympic marathons. He ran in world record time in both victories. Mamo Wolde, another Ethiopian marathon winner, competed in the 1968 Summer Olympic Games in Mexico. Since then, Ethiopia has dominated long-distance running contests. Miruth Yifter, known as "the shifter," rose to prominence in the 1970s and 1980s, winning both the 5,000m and 10,000m races in the 1980 Moscow Olympics. A flurry of world and Olympic champions appeared after 1990. During this period, Derartu Tulu, Gete Wame, Fatuma Roba, and Haile Gebrselassie began to win the world and Olympic titles. Fatuma Roba won the women's marathon in the 1996 Atlanta Olympics, while Derartu Tulu became the first black woman to win the 10,000m. In 1992, she earned her first Olympic medal at the Barcelona Olympic Games. Then, in Sydney in 2000, she won her second 10,000m Olympic gold medal. She also won a bronze medal at the 2004 Olympic Games in Athens. In Edmonton, Canada, Derartu Tulu, a 10,000m specialist, won the IAAF world athletics championships in 2001. She also won silver in the 1995 IAAF

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World Athletics Championships in Gotenborg. During this time, the legendary Haile Gebrselassie rose to prominence and began to dominate distance competitions ranging from the 3000m to the marathon. In the 5,000m and 10,000m, he won eight world championships and two Olympic crowns, setting 27 world records in the process.

After Haile Gebrselassie, a double and multiple world and Olympic champion, Kenenisa Bekele dominated the 5,000m and 10,000m for more than a decade, and he had never been beaten in the 10,000m for ten years. He won 26 gold, three silver, and two bronze medals for his country on an international level. In both the 5000m and 10,000m, he held the world record in both. He is also the first athlete in history to win 11 gold medals at the World Cross Country Championships. Furthermore, he is presently the second fastest marathoner (2:01:41), having missed the world marathon record just by 2 seconds in 2019. Ethiopian female athletes have also won many worlds and Olympic titles, including Derartu Tulu, a two-time Olympic and one-time world winner. Tirunesh Dibaba is a three-time Olympic gold medallist, five-time world champion, four-time world cross-country champion, and two-time African champion gold medalist, with a total of 14 gold, four silver, and three bronze medals (21) for her country on the international stage. Meseret Defar has won medals at the highest levels of international competition, including gold medals at the Olympic and World Championships in the 5000m. She won the Olympic Games twice, the World Championships twice, the World Indoor Championships four times, the World Junior Championships twice, and the African Championships once. At the international level, she won 11 gold, 8 silver, and 3 bronze medals for Ethiopia. Ethiopian athletes such as Silesh Sihin, Almaz Ayana, Genzebe Dibaba, Asefa Mezgebu, Gezahegn Abera, Meselech Melkamu, Worknesh Kidane, Birhane Adere, Tariku Bekele, Gebre Egziabher Gebremariam and others have won gold, silver, and bronze medals at Olympic and world championships. Ethiopians are currently the fastest athletes in the long-distance events of sports, including the 5,000m, 10,000m, half marathon, and marathon. For example, many races were canceled or postponed once Covid-19 began. However, on the 4th of October 2020, the London Marathon organizers organized the 40th Virgin Money London Marathon, which was exclusively open to top participants. In this race, 5 male and 2 female Ethiopian athletes participated. Surprisingly, the male Ethiopian athletes dominated over their longtime rivals from Kenya, and all Ethiopian athletes finished the race in the top 6 and the females finished in the top 3. Among the top 6 athletes, the second-placed athlete was from Kenya, but the rest are Ethiopian (1st, 3rd, 4th, 5th & 6th). This shows that Ethiopia is dominating the long-distance races even during difficult times.

Ethiopia and Kenya are multi-cultural and diverse countries with a diverse ethnic population, and many experts have determined that successful Ethiopian and Kenyan athletes came out from the same geographical location, region, and tribe (Onaywera et al., 2016; Scott et al., 2003). Before the 2000s, most Ethiopian athletes representing Ethiopia in international competitions were from the same geographical location and ethnic group, i.e. Oromia, Arsi region. According to my research and the current status of Ethiopian athletes, many distance events are mainly seen throughout Ethiopia, which has been dominated by athletes from the Amhara region since 2012. In this study, the female profile of long-distance athletes in Ethiopia is examined. Some athletes are successful in track events and marathon events i.e., first start in track events and then change disciplines to marathons as they get older, and they are successful in both track events and road races (Wilson, et al., 2005).

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Many factors have been identified that influence success in long-distance running. The observation of significant relationships between VO2 max, the proportion of slow-twitch fibers, the proportion of VO2 max that can be utilized, and running economy has linked these and several other factors to their success (Costill et al., 1976; Cristóbal et al., 2020). The physiological characteristics and abilities of the elite athlete develop from a combination of genetic predisposition and strenuous physical training (Ruiz et al., 2009; Saltin, 2003). While we believe that these physiological factors are some of the most important determinants of athletic success, Running events from the middle to long distances are dominated by East African black runners (Larsen, 1955). These populations may have a genotypic or phenotypic advantage when it comes to endurance running; several researchers have looked for phenotypic differences between black and white endurance athletes from South Africa, Kenya, and Eritrea (Bosch et al., 1990; Lucia et al., 2006). Studies indicated that black runners had a higher percentage of their maximal oxygen consumption (VO2 max) either during a simulated treadmill marathon (Larsen, 2003; Bosch et al., 1990), higher percentage of their VO2 max marathon or at a 10-km race pace compared to their fellow white runners (Weston et al., 2000). Several studies have found that black endurance runners have lower blood lactate concentrations during submaximal exercise testing and have a comparatively high muscle lactic acid tolerance (Coetzer et al., 1993).

2. METHODOLOGY

2.1. Subjects

The study was carried out on 11 elite female distance athletes who have an average age is 28.2 ±4.0 yrs, with a height of 162.3 ±5.4 cm, a weight of 47.3 ±3.6 kg, a BMI of 18.0 ±1.1, a training age of 9.8 ±4.8 yrs age, and weekly distance/training volume of 186.9±2.9km, and workout intensity of slow, moderate, to high. Their half marathon personal bests are 01 hr 06 min 19 s [0.8], while their marathon personal bests are 2 hr 19 min 26 s±0.02. At the time of the study, all athletes are participating in half marathons and marathons. All of them are national team athletes who have been representing Ethiopia in international competitions like African Championships, IAAF World Championships, World Cross Country Championships, and Olympic Games, and in platinum and gold label road races. All of them are medalists and top 20 athletes in the World Athletics ranking system. They are from different ethnic groups but are currently living and training in the capital city, Addis Ababa. All of them are high-altitude natives and have always lived in the high central plateau of the country (altitude varying from 2000m to 3300 m). Currently, most of them live in Addis Ababa, the capital (altitude near 2500 m), and train up to 3300 m, Entoto.

2.2. Data Collection Tools

The following physical and physiological parameters of participants were measured on the field and in the laboratory tests [age, mass, height, BMI, Vo2Max or cooper VO2 max test, Heart Rate (RH and EHR), and fat percentage (%body weight) will be determined]. The athletes have been representing their country in international tournaments. The athletes both males and females will be selected in the top range by IAAF score. Their personal bests (PB) of 10,000 m, 10k, 15k, 21k, and 42k events were taken from World Athletics athletes' profiles. Their performances rank, and scores were also obtained on World Athletics athletes' profiles. The personal best (PB) time for all of them was taken from the world athletics data record 5000 m. The runners were tested from November 2020 to February 2021.

The ethics committee at Gazi University gave their approval to the project. All the subjects were healthy, free from injury, and fill out a voluntary participation form, which is used to receive their written consent

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before participating in this study. The context of the study was briefed to participants, with all details. Before the measurements will be done, all the participants will be warned about alcohol consumption and not exhausting themselves with heavy training a day before the study. Subjects undergo the following measurements, respectively: Height and weight measurement, body composition analysis, and evaluation of breathing parameters. The anthropometric and Physiological equipment was calibrated before the assessment period, with additional checks made against National Association of Testing Authorities certified calibration. The status of all elite athletes is Gold or Platinum status with World Athletics (WA). Their daily, weekly, and monthly training data were confirmed with each runner's coach Performance results were noted from each athlete's records during the period they attended various training centers and at international races (World Athletics Athlete Profile).

2.3. Anthropometric Data

Anthropometric measurements (height, weight, BMI) and body composition were performed by Digital standing scales (Model TANITA MC-980 Body Composition Analyzer) are used to determine results to the nearest 0.1 scale which is currently functioning in the universities and sports centers. This is the latest clinically accurate Multi-frequency BIA Technology that most researchers use. The MC 980 body composition analyzer sats a new performance standard in body composition analyzer 8 electrodes use 6 frequencies to allow high accuracy to measure each arm, leg, and trunk area. The flexible integrated Microsoft software enables easy download of the stored data via USB for comfortable data management and research analysis. The system is easy to use Flexibility windows operating system enables comprehensive using data management and analysis for consulting progress tracking. It is easy to use accessible easy-to-use touch screen making the MC 980 a reliable body composition analyzer.

A caliper gauge (Holtain Ltd, Crymych, UK) calibrated to the nearest 0.2 mm was used to measure skinfold thickness. The average of three skinfold measurements was used in the analyses. The sum of 6 skinfolds (triceps, subscapularis, supraspinal, suprailiac skin, abdominal skin, and thigh). BMI was calculated as weight/height2, with body mass in kilograms (kg) and height in meters (m). Training characteristics we recorded the main training characteristics of each runner from their training diary. The information was double-checked with each runner's coach. Subjects were asked to explain the normal training week over the preceding 3 to 4 months, as well as other characteristics such as the altitude where they live and train (typically 2400-3300 mm in Ethiopia), previous training experience, and the number of hours of sleep. Using conventional equipment, the patients' body mass, height, and body mass index (BMI) were recorded, as well as six skinfold measurements (triceps, subscapular, supra-iliac, abdomen, anterior thigh, and supraspinal) (Holtain, Crymych, UK). The same researcher took three skinfold measurements in duplicate.

2.4. Determining VO2 max

We used the h/p cosmos Saturn Treadmill, Germany VO2 max (ml/min/Kg) testing for athletes. All subjects completed a continuous graded exercise test on a treadmill (h/p cosmos Saturn Treadmill, Germany) to determine their maximal oxygen consumption (VO2max) and ventilator threshold (VT). Heart Rate, gas exchanges, and ventilation will also be measured with this device at a time. It is supposed to this device is good for stability, validity, and reliability. The quality of this treadmill is also extraordinary and it is a very useful tool for my study. The Saturn treadmill can be linked with most medical CPET devices and with a multitude of upgrade options can be a complete physiological testing

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system. The h/p cosmos Saturn Treadmill is used by world-class sports performance facilities around the world, the unique h/p/cosmos Saturn treadmill provided a platform for athletes and coaches to achieve high-performance training within the laboratory. This gives the athlete and the coach the opportunity to simulate and conduct physiological testing that cannot be achieved during outdoor sessions. This treadmill machine can analyze and interpret data by itself. Measurements were carried out in the Physiology Laboratories of the universities and the Olympic Preparation Centre.

2.5. Data Analysis

Standard descriptive statistics such as mean and standard deviation were used to present participant characteristics for all variables. Variables were tested for their skewness. All fitted to a normal distribution. Standard descriptive statistics (mean, s, and range) were used to present the characteristics of the subjects for all directly measured and derived variables.

3. RESULTS

The physical and physiological characteristics of the test parameters of the elite Ethiopian athletes are shown below in different tables. BMI and the sum of 6 skinfolds were lower but within the norm in Ethiopian athletes. Ethiopian athletes have high VO2 max (mLkg-1min-1) at all running speeds. The VO2 max was determined by the Cooper test as well. According to Cooper's test assessment of normative data, Cooper (1968) is excellent for male athletes running more than 2700m in 12 minutes and female athletes running more than 2000m (French & Long, 2012). The Cooper Test is used to check an athlete's aerobic endurance progress and determine their maximum oxygen consumption (Cooper, 1968). A 400-meter track was used, a timer, a whistle, and an assistant to conduct this test. Athletes should run as far as they can in 12 minutes. The athletes generally train with separate trainers, but after discussing with them, I decided to perform the test at the Addis Ababa track and field stadium. It is simple to test the athletes because they were in the high-intensity training and competition period. They changed their clothes and began the main exercise after a 20-minute warm-up and dynamic strengthening. After that, the athletes were ordered, and the assistant gave the signal "GO," which started the timer, and the athlete began the test. The athletes were informed of the remaining time at the end of each 400m lap. Finally, we blow the whistle when the 12 minutes are up and note the distance the athlete has run-up to the 12 minutes. According to Brian Mac, Cooper VO2max test, an estimate of your VO2 max can be calculated from the Cooper Test results as follows: (distance traveled in meters - 504.9) ÷ 44.73 (David,2019). For example, Tirunesh Dibaba covers 4200m in 12 minutes and his VO2 max estimate will be 82.6 ml/kg/min. Besides, the watch Garmin Forerunners measures heart rate, VO2 max, and other parameters to make athletes use it. The test result is analyzed by comparing it to the athlete's previous test results. The analysis should show an improvement in the athlete's level of fitness if sufficient training is done between each test. In addition, I got the results of each athlete's km they ran in 12 minutes from the IAAF athletes' profile list while competing in international track and road competitions. As a result, the findings of the 12-minute runners can be used to estimate the athletes' VO2 max by calculating the Cooper VO2 max, which is ideal for endurance sports (Rexhepi et al., 2014; Heward, 2006).

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Table 1. Physical characteristics and training profile of female long-distance runners in Ethiopia

Name of athlete	Age (yrs)	Weight (kg)	Height (m)	BMI	Training age(yrs)	Average distance/week
Ababil Yeshaneh	29	49	165	19.8	9	187
Tirunesh Dibaba	35	50	166	18.11	19	188
Gelete Burka	34	43	160	16.80	17	184
Worknesh Degefa	30	45	155	18.75	8	192
Roza Dereje	23	51	168	18.3	5	186
Ruti Aga	26	46	152	19.04	9	184
Meskerem Asefa	29	47	161	16.2	14	189
Yebrgual Melese	30	48	160	18.75	9	188
Helen Bekele	26	50	169	16.78	5	186
Birhane Dibaba	27	46	160	17.58	10	182
Degitu Azmeraw	21	50	169	17.48	3	190

Table 2. Cooper test (12 Minutes Run Test) of female athletes. Athletes' profile, personal best (PB), label status, and current world ranking position of athletes at World Athletics (WA)

Athlete's Name	12m run test	5,000 Mpb	10,000m PB	10k PB	15k PB	21k PB	42k PB	RRL	WAS	WRP
Ababil Y.	4100m	14:41	30:35	31:26	-	1:04:31	2:20:51	G	1285	1st
Tirunesh D.	4200m	14:11	29:42	30:30	46:28	1:06:50	2:17:56	G	1255	6th
Gelete Burka	4170m	14:31	30:26	30:53	49:26	1:06:11	2:20:45	P	1240	28th
Worknesh	3750m	-	-	31:53	-	1:06:14	2:17:41	P	1257	4th
Roza Dereje	3800m	-	-	-	-	1:06:01	2:18:30	P	1249	6th
Ruti Aga	3930m	-		31:35	49:20	1:06:39	2:18:34	P	1248	16th
Meskerem	3750m	-	32:31	-	-	1:07:42	2:20:36	P	1227	13th
Yebrgual	3610	-	31:40	-	-	1:07:18	2:19:36	P	1237	9th
Helen Bekele	3900m	-	30:50	-	-	1:06:45	2:21:01	P	1226	
Birhane D.	3810m	-	32:11	-	50:56	1:05:57	2:18:35	G	1248	3rd
Degitu A.	3905m	-	31:03	-	-	1:06:07	2:17:58	G	1254	8th

HM =Half Marathon, M=Marathon, PB=Personal Best, WA =World Athletics, WAS=World Athletics Score, WRP=World Ranking Position, P=Platinum, G=Gold, WR =World Ranking, RRR= Road Race Running.

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According to the IAAF Scoring Table of athletics 1400 points is the maximum score for all disciplines. Therefore, the score of the athletes at the top of the table is 1400m. The ranking system is based on the two main elements of all track and field performances: the athletes' measured results (result score) and their placement during the events (placement score). The combination of these elements results in the athletes' performance for each competition in which they participate (performance score). For the women, Letesenbet Gidey of Ethiopia is the world record holder in the 5,000m (14:06), whose score is 1269, and Almaz Ayana is the world record holder in the 10,000m (29:17), whose score is 1287 out of 1400. Ruth Chepngetich and Birgid Kosgei are Kenyan world record holders in the half marathon (1:04:02) and marathon (2:14:04) respectively. Their result points are 1295 out of 1400 points each. They also have the highest score in the world. All athletes included in my research whose score was given by the IAAF scoring system. Therefore, the ranking positions on the table were assigned by the IAAF based on their performance. According to the table above, Athletes like Worknesh Degefa, Ruti Aga, and Roza Dereje directly start competing in road races especially half marathons and marathons without track competitions.

Table 3. Results of female athletes in terms of distance covered in 12 minutes, resting heart rate; exercise maximum heart rate, estimation of vo2 max from distance covered in 12 minutes, the sum of skinfold thickness, fat percentage, and blood pressure

Athletes Name	RHR (bpm)	EMHR (bpm)	12m rt(m)	VO2 max	VO2 Max Ass.	SST (mm)	Fat %	BB/S/D (mmhg)
Ababil Ye.	48	178	4100m	80.4	Excellent	46.3	13.2	110/67
Tirunesh Di.	45	175	4200m	82.6	Excellent	48.2	15.9	111/72
Gelete Bu.	51	180	4170m	81.9	Excellent	44.9	14.3	115/69
Worknesh D	52	179	3750m	72.6	Excellent	47.8	17.1	118/70
Roza Dereje	47	173	3800m	73.7	Excellent	45.7	14.6	114/67
Ruti Aga	50	183	3930m	76.6	Excellent	51.2	16.5	119/73
Meskerem	49	182	3750m	72.6	Excellent	52.4	17.8	109/72
Yebrgual M.	47	177	3610m	69.4	Excellent	48.8	15.2	113/66
Helen Be.	51	180	3900m	75.9	Excellent	52.6	19.7	112/71
Birhane Di.	49	176	3810m	73.9	Excellent	47.2	15.5	114/70
Degitu Az.	50	181	3905m	76.0	Excellent	50.6	19.4	116/68

Bpm=beats per minute, RHR=resting heart rate, EMHR=exercise maximum heart rate, 12m RT= 12 minutes run test, VO2 Max=Maximum Oxygen Volume, VO2 Max Ass.=Maximum Oxygen Volume Assessment, SST=sum of skinfold thickness, PB=blood Pressure, S/D= systolic/diastolic.

HRmax = 220 - age is the most basic and well-known formula for calculating your maximum heart rate (HRmax). The standard male-based computation (220 - age) overestimates the maximal heart rate for age in women, according to (Gulati et al., 2010). In 5437 women, they looked at the connection between heart rate response to exercise tests and age. The average peak heart rate for women was determined to be 206 - (0.88 x age) (Whyte et al., 2008). All athletes' resting heart rates and maximum exercise heart rates, as measured by Garmin forerunners watches, are presented in the table above. When we employ the formula, though, the result is more or less the same. As an example, we can take the resting heart rate and

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loading heart rate of Kenenisa Bekele. He was the world record holder in 5,000m and 10,000m before 2020 and is currently the second-fastest marathoner of all time, only 2 seconds behind the world record holder. Therefore, his training heart rate is 177m. But we calculate with the formula 220-37=183 (Gulati et al., 2010), which is almost the same. Both men and women have very low resting heart rates. Not only their resting heart rate but also their exercise heart rate sometimes gets lower. Since they have great endurance, they can perform well with a maximum heart rate of 150-170bpm. A decrease in heart rate at certain intensity is usually due to improved fitness. The athletes run amazing times in the 12-minute run test, which is why their VO2max results are high and excellent (see Tables 2and 3). According to the fat percentage and skinfold thickness test, Ethiopian athletes have a lean body mass type.

4. DISCUSSION AND CONCLUSION

This study suggests that the top-class elite Ethiopian female athletes' physical and physiological characteristics. We have, first, to underline that we have focused this investigation on internationally elite runners which are, by definition, few (N=11). All physical and physiological parameters are tabulated below in (table 4). Table 4 Physical and physiological characteristics, training profile, Cooper test, VO2 max, resting and maximum heart rate, blood pressure, the sum of skinfold thickness, fat percentage (%), 42k, 21k, and 10-k running time (mean ± SD) of Ethiopian female and male elite runners. The mean values of total skinfold thickness and fat percentage (mean ± SD) for male and female athletes are summarized in the following table.

Parameters	Female	
	Mean	SD
Age (years)	28.2	4.0
Height (cm)	162.3	5.4
Mass (kg)	47.3	3.6
BMI (kg/m2)	18.00	1.1
Training age (years)	9.8	4.8
Weekly distance (km)	186.9	2.9
10k/10,000m (time, min: sec)	31:09	0.9
10k average speed (km/h)	19,213	0.5
Half Marathon time (hr: min: sec)	66:19	o.8
Half Marathon average speed (km/hr)	19,191	0.3
Marathon time (hr: min: sec)	2:19:26	0.02
Marathon average speed (km/h)	18,174	0.3
Cooper test/12minutes run test(m)	3902.3	178.6
Vo2 Max (ml/kg/min)	76.0	4.0
Sum of 6 Skinfold thickness (mm)	48.7	2.5
Fat Percentage(% Body weight)	16,3	1.9
Blood pressure test (Systolic/Diastolic)/mmHg	113.7/ 69.5	3.1/ 2.2
Resting Heart Rate (bpm)	49.00	2.00
Maximum/Exercise Heart Rate(bpm)	178.5	2.9

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Several physical and physiological factors have been proposed to explain the exceptional success of Ethiopian long-distance runners. The physiological factors underlying success in these running disciplines are maximal oxygen uptake (VO2max), running economy (RE), maximal oxygen uptake utilization (%VO2max), and anaerobic threshold speed (vAT) (Billat et al., 1996; David, 2019; Wilber & Pitsiladis , 2012). The VO2max of Ethiopian elite women long-distance runners competing at the international level ranges from72.6 to 81.9 ml/kg/min. It can be concluded that a high VO2max is necessary to compete at the national and international levels in running distances events (Bassett et al., 2000). However, according to (Tucker et al., 2015; Uth, et al., 2004; Vernillo et al., 2013; Weston et al., 2000; Williams, 2007) research works generally have an outstanding running economy that has more positive impacts on East African distance runners. In the 12-minute running test (Cooper test), they cover an incredible distance, ranging from 3750 m to 4200 m for women (Whitfield et al., 2014; Rexhepi et al., 2014). According to my research, high-intensity training, higher VO2 max, training at high altitude (Ozan et al., 2017; Robert et al., 2016), running economy, Cooper test score (David, 2019), low BMI, lower skinfold thickness, lower body fat percentage, and ectomorphic body composition make Ethiopian athletes so good (Cristóbal et al., 2020). This group of athletes is of interest to exercise physiologists because they are altitude dwellers (2000-3400 m) and train and live at higher altitudes for long periods than most athletes in the world. It helps athletes to increase their VO2 max capacity. So training at a low oxygen place vs competing at an abundant oxygen place makes them perform very well (Larsen & Sheel, 2015; Ozan et al., 2017).

According to various studies previously conducted on the success of East African runners, VO2 max did not differ between European and East African endurance runners. East African runners do not have exceptionally high VO2 max or lactate threshold values, but generally have excellent running economy (Noakes, 2002; Whitfield et al., 2014), but in our research, we assumed that Ethiopians would be characterized by uniquely high values of maximal cardiorespiratory capacity (VO2max) (Wilson, 1990), which have a major impact on their performance with running economy. For female athletes, the half marathon ranges from 1:04:31-to 1:06:45, except for one athlete running 1:07 (see Table 2). In the 5,000 m and 10,000m, a lot of Ethiopian female athletes could run under 14:30 and 30 minutes respectively.

Physical factors, as well as maximal aerobic power (VO2max), have been linked to running performance (Larsen & Sheel, 2015; Martin et al., 2013; Robert et al., 2016; Williams, 2007). Dotan et al. (1983) found a moderate connection between BMI and marathon running performance. Lower limb skinfold thickness was likewise linked to running time in long-distance races, according to (Arrese & Ostáriz, 2006). In terms of body composition, Brandon and Boileau (Larsen & Sheel, 2015) claim that having more fat-free mass makes runners more efficient. Wilson et al. (1990) also investigated the link between somatotype and physical performance in running competitions. Smaller, lighter, and slimmer body stature results in superior long-distance running performance (Cristóbal et al., 2020) (see Table 1&2). Although body size has a considerable impact on absolute VO2 max and lung volume, which differ significantly amongst population groups (Terados et al., 1955), however, the findings of this study imply that factors other than body size affect metabolic and/or mechanical efficiency (physical, mitochondrial, enzymes, cellular perfusion, etc.) may have a significant part in the success and supremacy of East African distance runners in general (Larsen & Sheel, 2015; Martin et al., 2013; Robert et al., 2016). Many studies have suggested that such characteristics may play a role in elite eastern and South African long-distance runners' success and dominance (Noakes, 2000; Tucker et al., 2013). Biomechanical aspects in running may help with performance by enhancing the running economy and preventing injury (Scott & Pitsiladis, 2007).

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According to our study, the dominance of Ethiopian runners in long-distance running, both globally and locally, implies a more dominant influence of Ethiopia-associated genetic and early life phenotypic factors than of later life factors on their performance in long-distance running in general (Wilber & Pitsiladis, 2012). Their average weekly distance (training volume) of 186.9 ± 2.9km, and workout intensity of slow, moderate, to high. The athletes from Ethiopia who were part of this study are among the high-level and successful athletes in the world according to their label status, rank position, and score in 2021 (see Table 2). According to the WA, 63.63% (7/11) and 36.37 %(4/11) of the women in the 11 samples have platinum and gold label status, respectively (Table 2). Ethiopian female runners were smaller with lower BMI, skinfold thickness, and body fat percentage. Table 4 reveals that the average age is 28.2 ±4.0 years, with a height of 162.3 ±5.4 cm, a weight of 47.3 ±3.6 kg, a BMI of 18.0 ±1.1, and a training age of 9.8 ±4.8 yrs. As a result of the research, it was discovered that as training age, weekly training volume, and biological age increase, performance improves (Larsen & Sheel, 2015; Wilber & Pitsiladis, 2012). In the study, female Ethiopian runners outperformed runners in 10 km, half marathon, and marathon running events and they run the best times (see Table 2). The Cooper test/ 12-minute run (m) that athletes cover a distance in 12 minutes on 400 m track was significantly extremely high (Rexhepi et al., 2014). It can be seen that Ethiopian female athletes achieved similarly high VO2 max peak values as well as treadmill speeds in the maximal treadmill tests, as would be expected for athletes of this caliber. Furthermore, when looking at the selected and relevant peak values (EMHR and RHR), it is apparent that maximal volitional efforts were achieved in the runners (see Table 3).

Ethical Text

"In this article, the journal writing rules and publication principles rules were followed. The responsibility belongs to the author (s) for any violations that may arise regarding the article. "The ethics committee at Gazi University gave their approval to the project.

Conflict of Interest

The author(s) declare no conflict of interest about the article.

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