VENTILATORY RESPONSES TO AEROBIC ENDURANCE FITNESS AND RUNNING ECONOMY IN FOOTBALLERS; ARE THERE ANY DIFFERENCES BETWEEN PLAYERS' POSITIONS

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Nəşr tarixi
Qəbul edilib: 1 iyun 2019
Dərc olunub: 5 iyul 2019

Annotation: Running economy is one of the factors contributing running performance. The athlete who use oxygen more economically is more successful. Currently, there is no research on this topic in Azerbaijan. Azerbaijani athletes have not been investigated on running economy before, so this will be the first research in this field in the country. By the end of this research more economical position on the pitch and comparison National Football Players with elite athletes has been identified.

Key words: running economy, football, VO2max, oxygen consumption, Endurance performance.

Running economy is one of the factors contributing running performance. According to definition given by Turner and Owings, better economy refers to running a longer distance for a given volume of consumed oxygen or to consume less volume of oxygen while running a constant distance (1).
Runners with good running economy use less oxygen than runners with poor running economy use at the same steady-state speed (2). Therefore, the athlete who use oxygen more economically is more successful.
According to Philo Saunders and David Pyne, running economy is a better predictor of performance than maximal oxygen uptake (VO2 max) in elite athletes who have a similar VO2 max.(3) The better economy will decrease the percentage of VO2 max required to sustain a given mechanical work and thus might be advantageous to endurance performance.
Several factors influence running economy. Physiological (core temperature, heart rate, V_E) and biomechanical (foot, leg, pelvis morphology) are among others. Smaller than average feet size, legs having more muscle mass around hip joint, narrow pelvis and low percentage of body mass are shown as biomechanical factors related to better running economy.(3) More acute knee angles during swing, not excessive arm motion (more economical runners tend to exhibit less arm movement), faster rotation of shoulders in the transverse plane are among kinematic factors improving running economy.(3)
There are also number of interventions to improve running economy. Hakkinen showed the effects of plyometric training through enhancing the muscles ability to generate power.(4) Effect of plyometric trainings on running economy also shown in Turner and Owings research.(1)
It has been suggested that a higher percentage of slow-twitch muscle fibres is associated with better running economy, indicating that metabolic activity or actual speed of contraction of the muscle fibers may influence running economy. A positive relationship was found between the energetic cost and the percentage of fast twitch fibres (5)
Running economy traditionally measured by running on treadmill in standard laboratory conditions.
Considering the prolonged demand of match play and importance of discussed topic in football, this study directed on indicating ten football players among 23 who showed highest Vo2 on anaerobic

threshold after cardiopulmonary exercise testing and were more economical in using oxygen. The next stage is identifying position of these players on the field. Thus, we may suggest players of which field position use oxygen more economically. The hypothesis is that those players with a higher anaerobic threshold are more economical in using oxygen. The information might be useful in identifying young potential Azerbaijani football players whose results in the future may be close to the elite football player's performance. In addition, comparison of VO2 max of American soccer players (79 ml/kg/min) or Elite football players (75 ml/kg/min) with Azerbaijani football-lers' results might be available in future.

Subjects

The sample included 23 junior male football players. They were tested on Cardio-Pulmonary Exercise (CPEX) testing machine. Average age of participants was 18,4 years. Before starting the test the main anthropometric parameters were measured: average weight 73,6 kg; average height 178,2 cm. ECG, Echocardiography and vital signs (blood pressure and saturation) measurement before each test ensured that each football player was in good health condition.

Written Informed consent obtained from each participant. Additionally, athletes signed an agreement providing permission for the use of their data in anonymous retrospective analysis. The Ethical Committee of Azerbaijan State Academy of Physical Education and Sport (ASAPES) had approved study.

Study protocol

All football players performed a maximal exercise test (ramp protocol) for VO2max determination. They were requested to maintain their usual dietary and to abstain from hard training and/or competition for at least 24 hours before testing procedure.

All athletes started followed ramp protocol for maximal exercise test. Rest period for 1 minute, grade 1; warm up – 3 minutes, speed 4km/h, grade 1: exercise – 6 km/h, grade 1, speed increasing 1 km/h each minute; recovery period – 3 minutes, grade 1. Test performed on a Valiant 2 treadmill. Running posture should be straight, erect, head up, and back straight. Holding on to the rails or to the arm of technician or physician is not allowed due to the fact that in this case amount of work performed by the athlete is reduced. Test performed until voluntarily exhaustion. During the test,verbal encourage-ment had been used to motivate athlete to continue the test and to give a maximal effort. Starting from fifth minute, each third minute of exercise (5^{th}, 8^{th}, 11^{th}, 14^{th} and eth) runner was asked about how he feels and thumb up or down indicated good or bad condition respectively. Athletes were not allowed to speak or to give other voice signals during the test.

Heart rates in beats per minute monitored during the test from modified 12-lead ECG tracings (Triomi Bluetooth ECG), and pulmonary gas exchange data was measured by breath-by-breath using an automated open-circuit gas analysis system (Cortex, Meta Control 3000, Cortex Metalyzer, Germany). This system measured consumed O2 and produced CO2. Flowmeter analyses ventilatory flow. The gas analyzers were calibrated immediately before each test using ambient air according to manufacturer instructions. Breathing frequency, heart rate, oxygen consumption and CO2 production, workload, ECG had been monitored during athletes performed the test. Average duration of each test was about 23, 4 minutes.

Analyzer gives the numbers for VO2 per each minute and VT%VO2max. The first ventilatory threshold (VT1) was described as the point of switching from moderate to heavy intensity activity. At this point of intense activity disproportionate increment in ventilation (VE) to VO2 consumption may be observed. The second

N	Participant	Position on the pitch *	VO2max	VT% of VO2max
1	17AFFA_0020	MF	51	108
2	13AFFA_0016	Def	52	102
3	23AFFA_0025	MF	62	102
4	11AFFA_0014	Def	51	100
5	6AFFA_0009	MF	57	97
6	20AFFA_0021	MF	52	96
7	7AFFA_0010	MF	53	94
8	21AFFA_0023	MF	54	93
9	8AFFA_0011	MF	56	93
10	22AFFA_0024	MF	46	91
11	10AFFA_0013	Def	50	90
12	4AFFA_0007	MF	54	87
13	19AFFA_0004	Fwd	60	87
14	14AFFA_0017	MF	55	86
15	3AFFA_0003	MF	47	83
16	1 AFFA_0001	MF	55	82
17	16AFFA_0019	MF	56	70
18	18AFFA_0022	MF	61	69
19	12AFFA_0015	MF	45	50
20	9AFFA_0012	Def	54	47

Table 1.

disproportionate increase in ventilation is named respiratory threshold (VT2) and shows highest sustainable level of activity.

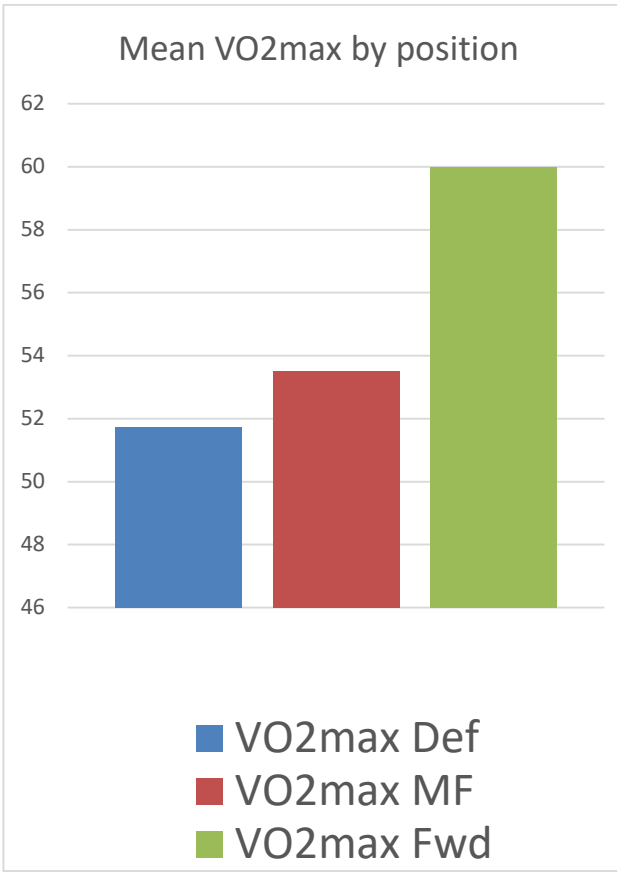
VO2max was considered as the highest at least 5 second achieved during test. All results were extracted in excel files in the end of each test.

Results and Analysis

Results of 20 out of 23 footballers were analyzed. 3 out of 23 players were goalkeepers. Their results weren't included in the analysis as they are not expected to cover long distances during a match. The rests were 1 forward, 4 defenders and 15 midfielders. That was the discrepancy of the research that we hadn't take equal amount of players of each position on the pitch. That would make results more precise and accountable.

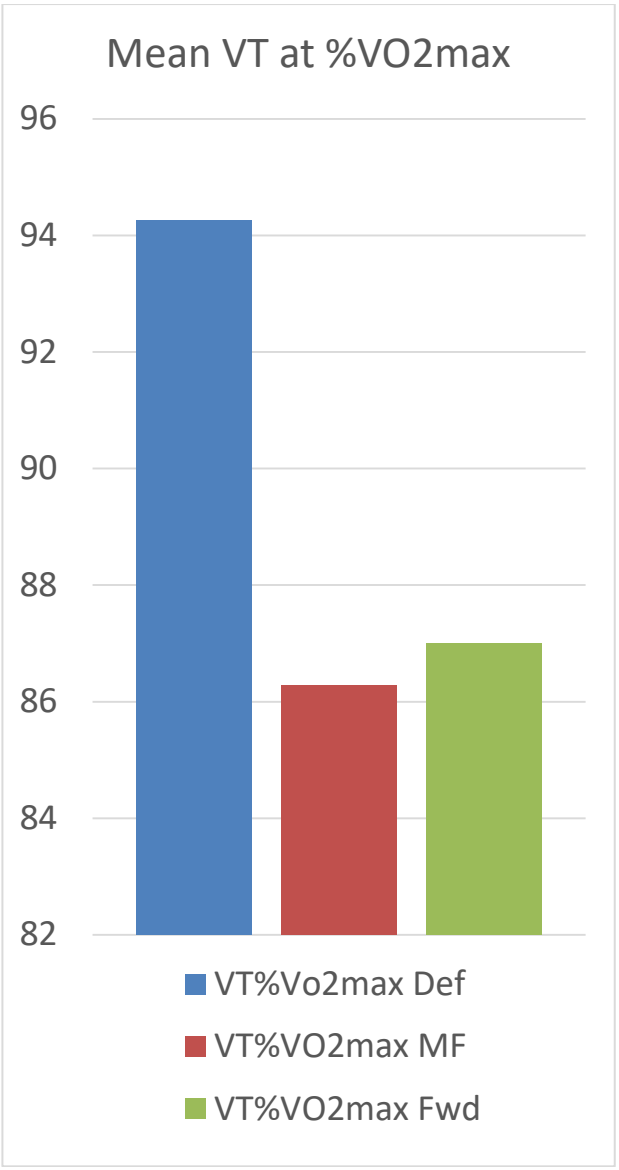
The numbers for Vo2max and VT % VO 2 max shown in table 1.

*MF- Midfielder, Def – Defender, Fwd – Forward.



Picture 1. Mean VO2max by position. (The average VO2max identified as 53,8. Average VO2max for defenders 51,75 ml/min/kg; for forwards 60 ml/min/kg (in this research we had only 1 forward); for midfielders – 53,5 ml/min/kg)

Average numbers for VO2 max, VT% of VO2max and average economy slope for each position are shown in table 2.



Picture 2. Mean VT at %VO2max. *(VT% of VO2max for defenders identified as 94; for forwards 87 (in this research we had only forward); for midfielders –86).*

Position	VO2 max	VT%VO2max	Economy slope
Forwards	60	87	1.7
Defenders	52	94	1.9
Midfielders	54	86	1.93

Table 2.

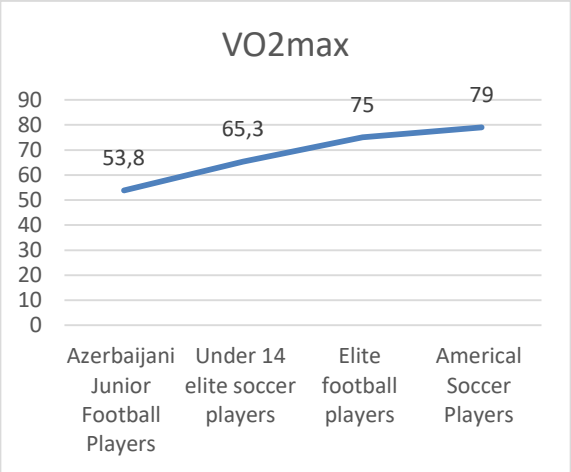
The main limitation of the research is the small number of included athletes. The other constraint factor is recruiting junior footballers instead of highly trained professionals. Considering professional football players have more efficient biomechanics and physiology than juniors and skeletal maturity status affecting VT1, VT2 and VO2max, future researches in this field are necessary. This may allow individually and specifically tailor the training program for each athlete.

Conclusion. By the end of research, we were able to identify that midfielders have highest VO2 at VT and therefore are more economical in using oxygen and have more running economy than other positions on the pitch. This is an expected result due to the fact that they occupy the middle position in the field and their role is to link the defense and offense.

However, these results have not identified midfielders by their position on the pitch whether it is central or side midfielders. This would be another point for future researches.

Further work is required to assess this parameters not after 24 hours rest period but after 45-60 minutes running, due to the fact that numbers and indicators may change in specific conditions.

Discussion



Picture 3. Comparison of Azerbaijani Junior Football players Vo2 max results with results of international football players.

That means that Azerbaijani junior team football players are not trained enough. Conducted studies suggests that adult footballers cover about 10-12 km distance during matches. Juniors (15 years old athletes) run shorter distances, approximately 8,1 km with VO2max indicator approximately 60 ml/kg/min. [17] This research is another chance for coaches to identify the weak points, set up a training program to reach the development and conditioning level of highly trained professional athletes.

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Экономия энергии и метаболические изменения у футболистов во время аэробных тренировок: разница в зависимости от позиции на поле.

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Аннотация: Экономия энергии один из факторов, влияющих на результативность. Спортсмен, который использует кислород в меньшем количестве, является более успешным. На данный момент в Азербайджане не было проведено научных работ в этом направлении. Азербайджанские спортсмены не обследовались на предмет экономии энергии до настоящего времени. К концу этой раучной работы была определена самая экономичная позиция на поле и было проведено сравнение национальных и элитных футболистов.
Ключевые слова: экономия энергии, футбол, потребление кислорода, выносливость, результативность.

Futbolçularda aerobik dözümlülük təlimləri zamanı metabolik dəyişikliklər və enerji qənaəti: futbolçuların mövqedən asılı olaraq fərqləri.

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Annotasiya: Qaçış qənaəti idmançının nəticəsinə təsir göstərən faktorlardan biridir. Oksigeni az miqdarda işlədən idmançı daha uğurludur. Azərbaycanda bu vaxta qədər bu istiqamətdə heç bir elmi iş aparılmamışdır. Azərbaycanlı idmançılar qaçış qənaəti mövzusunda bu vaxta qədər müayinə olunmamışdır. Bu elmi işin sonuna meydançada ən qənaətçil mövqe müəyyən olunmuşdur. Eyni zamanda milli və elit futbolçuların müqayisəsi aparılmışdır.

Açar sözlər: qaçış qənaəti, enerji qənaəti, futbol, oksiqen istehlakı, dözümlülük, nəticə.