

Assessment of aerobic resistance in the young soccer player

FRANCESCO PASTORE¹, FELICE DI DOMENICO², ILARIA VISCIONE³, FRANCESCA D'ELIA⁴
^{1,2,3,4} University of Salerno, ITALY

Published online: October 22, 2019

(Accepted for publication: October 15, 2019)

DOI:10.7752/jpes.2019.s5290

Abstract:

The objective of the study was to evaluate the evolution of aerobic resistance in young soccer players between 12 and 14 years old through the execution of specific field tests. After analyzing the results obtained in September, we proceeded to plan an individual training program for each player in relation to their physical condition (Gualtieri et al, 2006), and at the end of the season the test was repeated to observe any improvements. The study takes into account two different football seasons: the 2017 - 2018 season in which the aerobic resistance was assessed through the MOPER test and the 2018 - 2019 season where the Gacon test was considered. From the analysis of the results it is possible to observe the improvements obtained by the young players; in fact the comparison of the MOPER test data shows how the boys have increased their aerobic endurance by improving the distance covered during the test by around 30%; instead from the results obtained through the Gacon test it emerges that the VAM team average (16.7 km / h) is in line with the study carried out by Mendez-Villanueva (VAM under 18 = 17.2 ± 0.8 km / h) (Mendez-Villanueva et al, 2012). Through the execution of the MOPER test and the Gacon test we were able to observe and monitor the evolution of the aerobic resistance of each player, being in agreement with how important the evaluation tests are during the football season.

Key words: aerobic endurance, young players, soccer, MOPER test, Gacon test.

Introduction

Soccer is traditionally known as one of the most famous sports in the world (Smaros, 1980) and is practiced every day by millions of people of different ages, skills and sex (Castagna et al., 2014). Its multifactorial nature means that complexity is one of its main characteristics, since the technical, tactical, psychological and athletic elements that characterize it are various and different (Bangsbo et al, 1991). To ensure that a player can reach a good level of competitiveness it is necessary that he develops and trains all the physical abilities (Tiziana et al., 2017, Raiola, 2013) that characterize this sport. Among these abilities there is the stamina, which in football constitutes an importance capability (Arcelli, Ferretti, 2004), as it represents in the football player that particular motor skill that allows him to make body movements quickly, to be effective in specific technical gestures and to be focused during the whole match. Developing and training stamina is therefore a focal point in the growth of each player (Esposito et al, 2019). To evaluate and monitor this ability, specific tests are used, especially the field tests which, thanks to their simple, economical and fast realization, allow to obtain important information at different times of the season.

The objective of the study was to evaluate (D'Isanto et al, 2019) the evolution of aerobic endurance in young football players between 12 - 14 years old through the performance of two specific field tests: the MOPER test and the Gacon test.

Material and methods

For this work we have taken into consideration the results of two tests, that of Moper and that of Gacon. Both tests were performed by the young football players of the Atletico Nocera football school. The tests were performed two times during the football season; a first time back from the summer break and a second time, in May, at the end of the sport season. The data we are going to observe refer to the 2017-2018 season as regards the Moper test, while those relating to the Gacon test refer to the results obtained by the boys in the 2018-2019 season. The MOPER test carried out in the 2017-2018 season involved 14 boys aged between 12 and 14 years old. The objective of the test is to cover the greatest possible distance in 6 minutes around a total hexagon-shaped path of 150 meters (Kemper et al, 1980).

In addition to the distance traveled, the heart rate of each player was also noted at the end of the test and after 1 minute, that rate was measured through the carotid pulse. Being an aerobic test of moderate intensity, generally the range of heart rate parameters in which to work ranges from 70% to 90% of the HR max. After the data of the first trial were collected (September 2017), a training program, focused on continuous running work was planned (Raiola, D'Isanto, 2016) in order to improve the aerobic endurance ability. In May 2018, the test

was performed again to observe any improvements during the year. In the 2018-2019 season the Gacon test was performed; this test involved 12 players always aged between 12 - 14 years old. This is an intermittent maximal incremental test; it provides for an alternation of 45-second running sections, with moments of recovery of 15 seconds. The initial speed is 10 km / h, which corresponds to a stretch of 125 meters. After a pause of 15 seconds, 6.25 meters more are run (total 131.25 meters, equal to 10.5 Km / h) and so on until the athlete fails to cover the distance set in 45 seconds (Pillitteri, Licciardi, 2019).

It is possible to perform the test on a soccer field or track of athletics, a sound track is needed or eventually an assistant will mark the time through a whistle, while for the material part it takes 16 -18 total cones with 2 different colors to signal the various steps (Rago et al. 2017). The Gacon test allows us to know the VAM (Maximal Aerobic Speed) of our players, identifiable through the speed maintained in the last step before the end of the test, furthermore it is also possible to know indirectly the VO_2max (Maximum Oxygen Consumption). Knowing the VAM of our athletes, it will be possible to set the distances to be covered in the various intermittent type proposals during training (Ceruso et al., 2019).

Obtaining the results is very simple and immediate. To have the VAM value of our athlete, it is sufficient to consult the reference table (Table 1), where after identifying the last step performed by the athlete, it will be sufficient to scroll horizontally the corresponding row to have the value desired.

Table 1. Reference data Gacon test

	STEP	Range speed km/h	Range meters	VO_2max	Range per 30"-30"	Range per il 20"-20"	Range per il 10"-10"
Come	1	10	125	30	83	56	28
Back	2	10,5	131,5	32	88	58	29
Come	3	11	138	33	92	61	31
Back	4	11,5	144,5	35	96	64	32
Come	5	12	151	36	100	67	33
Back	6	12,5	157,5	38	104	69	35
Come	7	13	164	39	106	72	36
Back	8	13,5	170,5	41	113	75	38
Come	9	14	177	42	117	78	39
Back	10	14,5	183,5	44	121	81	40
Come	11	15	190	45	125	83	42
Back	12	15,5	196,5	47	129	86	43
Come	13	16	203	48	133	89	44
Back	14	16,5	209,5	50	138	92	46
Come	15	17	216	51	142	94	47
Back	16	17,5	222,5	53	146	97	49
Come	17	18	229	54	150	100	50
Back	18	18,5	235,5	56	154	103	51
Come	19	19	242	57	156	106	53
Back	20	19,5	248,5	59	163	108	54
Come	21	20	255	60	167	111	56
Back	22	20,5	261,5	62	171	114	57
Come	23	21	268	63	175	117	58
Back	24	21,5	274,5	65	179	119	60

Following the analysis of the results of the test carried out at the beginning of the season (September 2018), an intermittent training plan (Gaetano, Rago, 2014) was chosen in work mode 10"- 10"; 20"- 20"; 30"- 30", with an intensity no more than 100% of the VAM recorded during the test. At the end of the season (May 2019) the Gacon test was performed again to see if there were improvements regarding the increase in VAM and consequently the VO_2max , so as to recover more quickly the intense efforts made during the match and then to have a better physical hold over its entire duration.

Results

Table 2 shows the results obtained in the MOPER test in September 2017. From the percentage of work in the table we can see that all the players gave their maximum effort during the test. The average distance traveled is 1014 meters; observing the values of the heart rate measured after 1 minute it emerged that the boys had difficulty recovering from the effort as it was reduced by just 10% -15% compared to the value obtained immediately after the test.

Table 2. MOPER test data September 2017

	SURNAME	AGE	TURNS COMPLETED	TOTAL DISTANCE	HR end of test	HR after 1'	% work
1	ATHLETE (A)	13	5 + 3 sides	825 m	156	108	75,3
2	ATHLETE (B)	13	8 + 2 sides	1250 m	180	132	86,9
3	ATHLETE (C)	14	8 + 3 sides	1275 m	180	156	87,3
4	ATHLETE (D)	13	6 + 3 sides	975 m	180	132	86,9
5	ATHLETE (E)	14	5 + 2 sides	800 m	156	120	75,7
6	ATHLETE (F)	13	6 + 1 side	925 m	168	132	81,1
7	ATHLETE (G)	12	6 + 3 sides	975 m	180	132	86,5
8	ATHLETE (H)	12	6 + 1 side	925 m	156	120	75
9	ATHLETE (I)	12	7 + 3 sides	1125 m	168	132	80,7
10	ATHLETE (L)	13	8 + 1 side	1225 m	180	144	86,9
11	ATHLETE (.)	12	6 + 4 sides	1000 m	168	120	80,7
12	ATHLETE (N)	12	6 + 4 sides	1000 m	180	132	86,5
13	ATHLETE (O)	13	5 + 3 sides	825 m	156	108	75,3
14	ATHLETE (P)	14	7 + 1 side	1075 m	180	144	87,3

The following table (table 3) shows the results obtained in the May test, at the end of the football season. As we can see, all the boys were able to cover a greater distance than the one recorded in the test carried out in September. They, in improving their total distance, maintained a work intensity between 80% and 90% of HRmax; this means that they were able to complete the test giving the maximum effort and were able to recover more quickly the effort made considering the fact that their HR after 1 minute had decreased by about 30%.

Table 3. MOPER data test May 2018

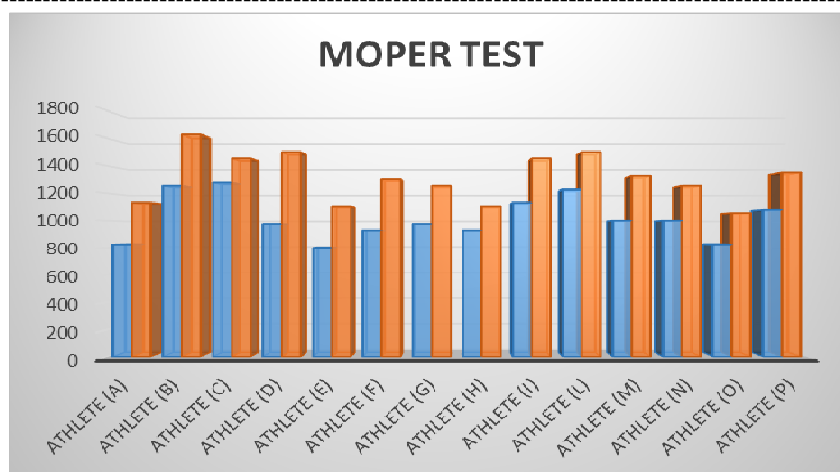
	SURNAME	AGE	TURNS COMPLETED	TOTAL DISTANCE	HR end of test	HR after 1'	% work
1	ATHLETE (A)	13	7 + 3 sides	1125 m	168	120	81,1
2	ATHLETE (B)	13	10 + 5 sides	1625 m	180	120	86,9
3	ATHLETE (C)	14	9 + 4 sides	1450 m	180	132	87,3
4	ATHLETE (D)	13	10	1500 m	180	120	86,9
5	ATHLETE (E)	14	7 + 2 sides	1100 m	168	108	81,5
6	ATHLETE (F)	13	8 + 4 sides	1300 m	180	132	86,9
7	ATHLETE (G)	12	8 + 2 sides	1250 m	180	144	86,9
8	ATHLETE (H)	12	7 + 2 sides	1100 m	168	120	80,7
9	ATHLETE (I)	12	9 + 4 sides	1450 m	180	132	86,5
10	ATHLETE (L)	13	10	1500 m	180	144	86,7
11	ATHLETE (.)	12	8 + 5 sides	1325 m	180	120	86,5
12	ATHLETE (N)	12	8 + 2 sides	1250 m	168	108	80,7
13	ATHLETE (O)	13	7	1050 m	168	120	81,1
14	ATHLETE (P)	14	9	1350 m	180	132	87,3

T-test on total distance covered (before and post) in Moper test

Coupled differences		Average		Confidence interval of		t	gl	Sign. (two-sided)
Average	Standard deviation	standard error	the difference in 95%	Lower	Higher			
VAR01								
VAR02	-378,571	334,24098	89,32966	-571,5564	-185,5864	-4,238	13	,001

Level of significance $p > 0.05$ - There is a significant difference between the two results (before and after) for the variable Total distance covered (0.001).

Graph 1 includes the data relating to the distance traveled both in the first test (in light blue) and in the second test (in orange); the gray parallelepiped indicates how much the distance traveled in the second test has increased compared to the first. As we can see the total distance traveled is increasing on average by about 25% for each boy.



Graph 1. Distance traveled values

In table 4 we can instead observe the results obtained by the 12 boys in the Gacon test performed in the first week of training, after returning from the summer break.

Table 4. Gacon test data September 2018

	SURNAME	FINAL STEP	LAST DISTANCE	TOP SPEED	VO ₂ MAX (ml/kg/min)	TOTAL DISTANCE
1	ATHLETE (A)	15	216 m	17 km/h	51	2557,5 m
2	ATHLETE (B)	12	196,5 m	15,5 km/h	47	1926 m
3	ATHLETE (C)	11	190 m	15 km/h	45	1732 m
4	ATHLETE (D)	12	196,5 m	15,5 km/h	47	1926 m
5	ATHLETE (E)	15	216 m	17 km/h	51	2557,5 m
6	ATHLETE (F)	11	190 m	15 km/h	45	1732 m
7	ATHLETE (G)	13	203 m	16 km/h	48	2132 m
8	ATHLETE (H)	12	196,5 m	15,5 km/h	47	1926 m
9	ATHLETE (I)	12	196,5 m	15,5 km/h	47	1926 m
10	ATHLETE (L)	11	190 m	15 km/h	45	1732 m
11	ATHLETE (M)	14	209,5 m	16,5 km/h	50	2341,5 m
12	ATHLETE (N)	12	196,5 m	15,5 km/h	47	1926 m

The VAM recorded after the Gacon test by all the athletes involved in the study is between 11 km / h and 15 km / h. The total average was equal to 15.75 km / h; considering the fact that the studies carried out by Mendez-Villanueva in 2012 state that the VAM in the under-18s is 17.2 ± 0.8 km / h, we can say that only the best two boys, Athlete (A) and Athlete (E), together with Athlete (M) who recorded a VAM of 16.5 km / h, approached this data, while the rest of the group was below average. The maximum oxygen consumption (VO₂max) results in an average of 47.5 ml / kg / min.

Table 5 lists the results obtained by each athlete during the test performed at the end of the football season.

Table 5. Gacon test data May 2019

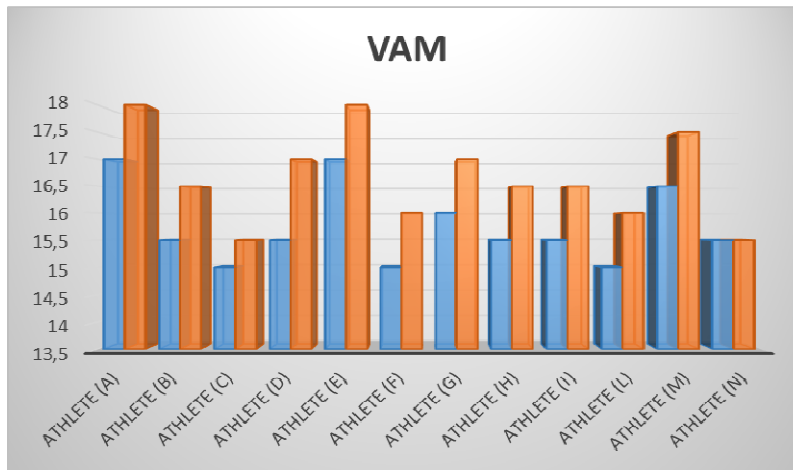
	SURNAME	FINAL STEP	LAST DISTANCE	TOP SPEED	VO ₂ MAX (ml/kg/min)	TOTAL DISTANCE
1	ATHLETE (A)	17	229 m	18 km/h	54	3009 m
2	ATHLETE (B)	14	209,5 m	16,5 km/h	50	2341,5 m
3	ATHLETE (C)	12	196,5 m	15,5 km/h	47	1926 m
4	ATHLETE (D)	15	216 m	17 km/h	51	2557,5 m
5	ATHLETE (E)	17	229m	18 km/h	54	3009 m
6	ATHLETE (F)	13	203 m	16 km/h	48	2132 m
7	ATHLETE (G)	15	216 m	17 km/h	51	2557,5 m
8	ATHLETE (H)	14	209,5 m	16,5 km/h	50	2341,5 m
9	ATHLETE (I)	14	209,5 m	16,5 km/h	50	2341,5 m
10	ATHLETE (L)	13	203 m	16 km/h	48	2132 m
11	ATHLETE (M)	16	222,5 m	17,5 km/h	53	2780 m
12	ATHLETE (N)	12	196,5 m	15,5 km/h	47	1926 m

T-test on total distance covered (before and post) in Gacon test

	Coupled differences		Average standard error	Confidence interval of the difference in 95%		t	gl	Sign. (two-sided)
	Average	Standard deviation		Lower	Higher			
VAR03	-386,5833	154,33904	44,55384	-484,64568	-288,52099	-8,677	11	,000
VAR04								

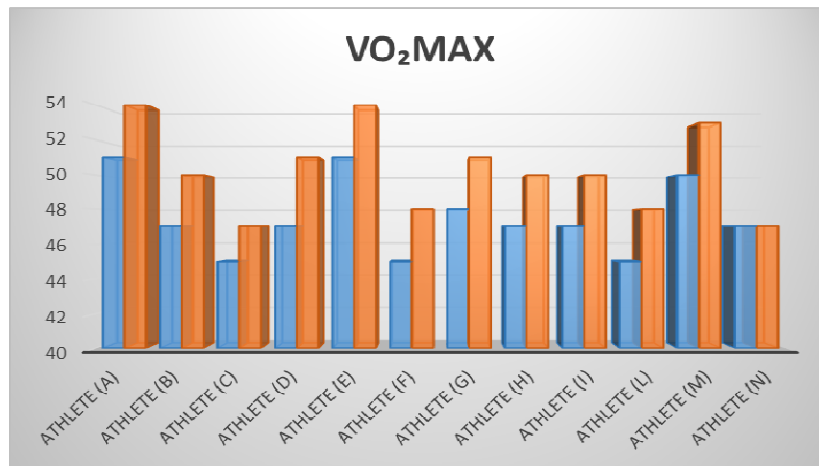
Level of significance $p > 0.05$ - There is a significant difference between the two results (before and after) for the variable Total distance covered (0.000)

From the analysis of these data we can observe that all the athletes, except for one, have completed at least one step more than what was done in the September test; consequently, their maximal aerobic speed is increased (Graph 2). In fact, the VAM registered by the athletes is between 15.5 km / h and 18 km / h; always taking as reference the studies carried out by Mendez-Villanueva who state that the VAM in the under-18s is 17.2 ± 0.8 km / h, we can see that more than 50% of the team falls within this reference range.



Graph 2. Comparison of VAM results

Furthermore, it is possible to observe (Graph 3) an increase in the value of the VO_2 max which presents an average of 50.25 ml / kg / min.

Graph 3. Comparison of VO_2 risultatimax results**Discussion**

The objective of the study was to evaluate the evolution of aerobic endurance in young players between 12 - 14 years old through the performance of two specific field tests: the MOPER test and the Gacon test.

The performance of the MOPER test and the consequent analysis of the results obtained allowed us to observe the improvements achieved by the boys in reference to their aerobic endurance ability (Altavilla et al. 2017). The analysis showed that the total distance traveled has increased on average by about 25% for each athlete (Graph 1). These improvements are due to the ability that the boys have developed and improved during

training, to increase their running speed while maintaining the heart rate below 90% of the maximum rate. This is possible because the heart, through training, has succeeded in increasing cardiac output under stress, satisfying the greater oxygen demands of the muscles, and therefore has improved its ability to withstand ever more intense and sustained efforts by increasing its own volume and reducing heart rate during exercise (Raiola, 2017). Instead, from the analysis of the data obtained from the Gacon test it emerges that during the football season almost all the players managed to increase their maximal aerobic speed (VAM) (Graph 2). Furthermore, as a consequence of the increase in VAM there is also an increase in VO_{2max} . In this case, the improvements obtained are the result of the advantages brought about by the intermittent training that allowed the athletes to improve their stamina; in fact, the intermittent run mode carried out at high intensity, through the sudden increase of the heart rate during the intense effort phase and the consequent decrease in the short rest period, involves an increase in the VO_{2max} greater than what can be obtained with a continuous running training.

Conclusion

At the end of this study we can therefore testify how it is important to make use of evaluation tests during the football season in order to evaluate the performance and the athletic condition of a participant. From the data obtained from the execution of the tests we obtain very important information that allows us to draw up a highly specific training program depending on the characteristics of each athlete. Finally, the comparison of test results allows us to observe the improvements that the planned training has brought to individual players.

References

- Altavilla, G., Riela, L., Di Tore, A.P., Raiola, G. (2017). The physical effort required from professional football players in different playing positions. *Journal of Physical Education and Sport*, 17 (3), art. no. 200, pp. 2007-2012.
- Arcelli E., Ferretti F. (2004). Calcio preparazione atletica (la resistenza aerobica e lattacida nel calciatore dilettante). Edizione Correre, Milano.
- Bangsbo, J., Norregaard, L., Thorso, F. (1991). Activity profile of competition soccer. *Journal of Sport Sciences* (16: 110-116)
- Castagna, C., Iellamo, F., Impellizzeri, F., Manzi V. (2014). Validity and Reliability of the 45- 15 Test for Aerobic Fitness in Young Soccer Players. *International Journal of Sports Physiology and Performance* (9, 525 -531).
- Ceruso, R., Esposito, G., Federici, A., Valentini, M., D'Isanto, T., (2019). Preliminary work about the basis data for monitoring youth soccer team planning training *Journal of Human Sport and Exercise*, 14 (Proc2), pp. S251-S257.
- D'Isanto, T., D'Elia, F., Raiola, G., Altavilla, G. (2019). Assessment of sport performance: Theoretical aspects and practical indications, *Sport Mont*, 17 (1), pp. 79-82.
- Esposito G., Ceruso R., Valentini M., D'Isanto T. (2019). The use of enabling tests to provide a qualitative measurement of the sport skill level of small soccer players, *Journal of Human Sport and Exercise*, 14(3proc)
- Gaetano, R., Rago, V. (2014). Preliminary study on effects of hiit-high intensity intermittent training in youth soccer players, *Journal of Physical Education and Sport*, 14 (2), pp. 148-150.
- Gualtieri D., Castellazzi A., Andreoni S. (2006). Programmazione annuale dell'allenamento per Giovanissimi. Calzetti & Mariucci, Perugia.
- Kemper H., Bovend'eerdt J., Verschuur R. (1980). De MOPER fitness test, BV Editore De Vrieseborch.
- Mendez-Villanueva A., Buchheit M., Simpson B., Bourdon C. (2012). Match play intensity distribution in youth soccer. *International Journal Sport Medicine*. (34(2):101-10).
- Pillitteri G., Licciardi A. (2019). Controllo del carico nel calcio - aspetti teorici e pratici sull'utilizzo del GPS, Performance Lab.
- Rago, V., Pizzuto, F., Raiola, G. (2017). Relationship between intermittent endurance capacity and match performance according to the playing position in sub-19 professional male football players: Preliminary results, *Journal of Physical Education and Sport*, 17 (2), pp. 688-691.
- Raiola, G., D'Isanto, T. (2016). Assessment of periodization training in soccer, *Journal of Human Sport and Exercise*, 11 (Proc1), pp. S267-S278.
- Raiola, G. (2017). Motor learning and teaching method, *Journal of Physical Education and Sport*, 17, art. no. 236, pp. 2239-2243
- Raiola, G. (2013). Body knowledge and motor skills, *Knowledge Cultures*, 1 (6), pp. 64-72.
- Severino N. C., Peluso Cassese F., Izzo R., Viscione I. (2019). Self-perception about health and wellness effects on recreational five-a-side football athletes, *Journal of Human Sport and Exercise*, 14(3proc).
- Smaros, G. (1980). Energy usage during a football match. In *Proceedings of the 1st International Congress on Sports Medicine Applied to Football* (pp. 795-801).
- Tiziana, D., Antonetta, M., Gaetano, A. (2017). Health and physical activity, *Sport Science*, 10 (1), pp. 100-105.