“ALEXANDRU IOAN CUZA” UNIVERSITY IAŞI

THE FACULTY OF PHYSICAL EDUCATION AND SPORT

THE DOCTORAL SCHOOL IN THE SCIENCE OF SPORTS AND PHYSICAL EDUCATION

FIELD: THE SCIENCE OF SPORTS AND PHYSICAL EDUCATION

METABOLIC STRESS IN THE PHYSICAL EFFORT PERFORMED AT THE MAXIMUM OXYGEN RATE BY PERFORMANCE ATHLETES

DOCTORAL THESIS ABSTRACT

Scientific Tutor,
Prof. habil. Beatrice Aurelia ABĂLAȘEI, PhD

Doctoral Student,
Cezar HONCERIU

Iași, 2023

DOCTORAL THESIS LAYOUT

Keywords: maximal oxygen uptake (VO_2max), metabolic stress, effort intensity, training, football.

PART I

THEORETICAL BACKGROUND OF THE RESEARCH TOPIC

Theoretical conclusions

Depending on intensity, volume, and complexity, physical exercise can be considered a stress factor for the human body. The latter reacts immediately (through acute modifications) and in the long run (through tardive alterations), using an avalanche of adaptations at the level of the entire body, which acts as an integrative system.

Thus, metabolic stress can be defined as a physiological and biochemical process emerging during physical effort as a response to the build-up of metabolites and catabolism products (i.e., lactate, inorganic phosphate, hydrogen ions, etc.) in the muscle cells. This process sets up a chain of acute physiological and biochemical adaptations to complete the task and maintain homeostasis, and tardive modifications at the muscular, cardiovascular, and respiratory levels, and even concerning the entire body, to increase the physical potential of an athlete.

Various metabolic, mechanical, and physical variables influence general performance and the economy of effort during long-distance races. Such variables include primarily sex, body mass index, maximal oxygen absorption, training level, as well as anthropometrical characteristics and the efficient use of metabolic substrates. Among these variables, VO_2max dominates and explains over half of the total variety of the results.

It is essential to evaluate and identify maximal oxygen uptake to determine the individual level of aerobic exercise capacity. Such results can correlate with physiological, biochemical, sanguine, or salivary indicators. Physical exercises involving maximal oxygen uptake can alter the protein composition of plasma and saliva.

Numerous studies have analysed the correlations between the response of physiological or biochemical, sanguine, or salivary biomarkers to the effort specific to maximal oxygen uptake. Endogenous hormones like DHEA-S or cortisol (a glucocorticoid hormone secreted by the adrenal gland cortex as a response to physical, psychological, or physiological stress factors) play a significant role in the body's adjustment to exercising at various intensities. Besides the well-known long-term and short-term effects (improving the behaviour, cognition,

neuromuscular system, and metabolism) of exercising upon the body, it has been reported that the levels of hormones increase post-effort.

Cortisol plays a direct role in sporting efforts. It mediates the critical physiological processes that help to improve exercise capacity and recovery, for instance, by promoting the breakdown of proteins within the skeletal muscles into amino acids and the triglycerides within the fat tissue to be hydrolysed into free fatty acids and glycerol.

The literature shows evidence suggesting that the blood lactate parameters would be influenced not only by the level of aerobic physical training but also by other factors, thus changing the correlations between these lactate parameters and aerobic capacity and aerobic effort performance per se.

The findings of these studies broadened the insights into the body's functioning mechanisms and the means through which it responds to stress. The results also highlight many times, though, conclusions that fail to correlate, primarily due to different study protocols and various measuring and assessing methods.

PART II

THE APPLICATIVE PART OF THE STUDY

VO2max assessment and evolution in the competitive period

Preliminary study

Premises of the preliminary study

The effort specific to football games mainly involves the aerobic energy production necessary for muscle contractions throughout a match. It is essential to point out and assess maximal oxygen uptake or maximal aerobic velocity to determine aerobic exercise capacity among football players. A good maximal oxygen uptake level can contribute to sustained effort throughout the game. Given that the precompetitive training period was shortened due to the alteration of the championship structure, coaches have to continue specific physical training – including the development of VO_2max – in the competitive period. The purpose is to attain a plateau of optimal fitness to be maintained until the end of the season. There is a trend – increasingly preferred by players and used by coaches – trying to develop maximal oxygen uptake and aerobic endurance using technical and tactical means performed using the ball or

games in a limited arena. This aspect of training can be pleasant because it involves working with the ball or the ludic form of practice. However, some specialists believe it cannot ensure the effort volume and intensity necessary for all players to develop the maximal oxygen uptake and the abovementioned tardive modifications. In this respect, I organised a research study to get a better insight into the topic and to bring to the forefront a grounded perspective on this issue within the practice of the field.

Purpose, objectives, and variables of the preliminary study

The preliminary study's primary purpose was to evaluate how the aerobic component of physical training can be performed in the competitive period using only technical and tactical exercises executed with the ball and dynamic games on limited areas for a football team. The primary objective of the preliminary study is related to the evaluation of maximal oxygen uptake (VO_2max), of velocity at maximal oxygen uptake (VAM or vVO2max) through field trial, and of heart rate throughout the trial (Hr) and of peak heart rate recorded during the test (Hr_{max}). The tasks of the study involved the initial evaluation (VAM, VO_2max, Hr_{max}) and the reification of the training programme based only on practising the technical and tactical means with the ball or dynamic games executed in limited areas over nine weeks. It coincided with the competitive period of the team that participated in the study. Ultimately, the final evaluation (VAM, VO_2max, Hr_{max}) occurred.

Table 2 – The dependent or independent variables of the study

Independent variable of the study	**Dependent variables of the study**
Technical-tactical means within the training, performed to increase VO_2max	VO_2max ($ml.min^{-1}kg^{-1}$)
	VAM (km/h)
	Hr_{max} (b/min)

Hypothesis of the preliminary study

The hypothesis of the preliminary study is the following: the aerobic component within physical training to improve aerobic exercise capacity can be executed through exercises with the ball, based on technical-tactical means.

The statistics of results within the preliminary study

The following Table features the descriptive statistics of the results recorded in the preliminary research:

Table 4 – Descriptive statistics of the preliminary study

Descriptive statistics

	VO_2max_ initial	VAM_ initial	Hr_max_ VAM_initial	VAM_ final	VO_2max final	Hr_max_ final
Valid	18	18	18	18	18	18
Mean	59.217	16.594	193.667	16.611	59.394	193.167
Std. Deviation	2.247	0.626	9.592	0.579	2.05	7.532
Minimum	55.3	15.5	183	15.6	55.8	184
Maximum	62.5	17.5	218	17.5	62.5	211

To assess the hypothesis of the preliminary study, we applied the student T-test for the values of VAM (vVO_2max – the running velocity at which an athlete reaches maximal oxygen uptake), VO_2max (maximal oxygen uptake), and Hr (heart rate). The following Table illustrates the statistics resulting from applying the Paired Sample T-test:

Table 5 – Paired Samples T-Test analysis for the values of VO_2max, VAM, and Hr_{max}

Paired Samples T-Test

Measure 1		**Measure 2**	**t**	**df**	**p**
VO_2max_initial	-	VO_2max_final	-0.589	17	0.564
VAM_initial	-	VAM_final	-0.23	17	0.821
Hr_max_VAM_initial	-	Hr_max_final	0.615	17	0.547

Conclusions of the preliminary study

The results of the VO_2max, VAM, and Hr_{max}VAM evaluation show that players have a good aerobic training level; the data recorded are comparable to those presented by other authors.

The study's data on the velocity at maximal oxygen uptake (VAM_initial versus the VAM_final value) show that the training did not significantly improve this physical parameter. Still, it preserved the values of the initial testing.

The data of the study conducted regarding maximal oxygen uptake (VO_2max_initial versus the VO_2max_final value) show that the training performed did not entail a significant increase in this physiological parameter, but it preserved the values recorded at the initial testing.

The complex evaluation of VO_2max, evolution and correlations with anthropometrical, motor, and biological indicators – Primary purpose

Research objectives, purpose, and variables

The primary study aims – in the first phase – to assess the maximal oxygen uptake (VO_2max) and the maximum running speed duration at maximal oxygen uptake ($TlimVO_2max$). I comparatively measured physiological indicators in a group of athletes (young football players) using ergospirometry or field trials. Based on the results obtained, I proposed a running routine using individualised continuous and intermittent efforts per group of players (Table 13). This phase involved the initial evaluation and the implementation of the routine for nine weeks (Table 23), which coincided with the competitive period of the team participating in the study; I performed a final evaluation at the end. In addition, in the second part of the research, the study aims to analyse blood and saliva samples before and after the effort trial to underline the acute modifications within the athletes' bodies when they reach maximal oxygen uptake during exercise.

The research objectives include and replace its purpose by organising a study involving tests performed in the laboratory and field (blood and saliva biological samples were collected to assess maximal oxygen uptake and highlight the acute physiological and biochemical modifications). The study obtained the consent of the Ethics Commission within the Doctoral School in the Science of Sports and Physical Education.

Primary study hypotheses

General hypothesis 1 of the preliminary study is the following: the evaluation of physiological and anthropometrical indicators specific to aerobic effort in performance athletes, i.e., football players, can highlight the individual training level.

Secondary hypothesis 1: the evaluation of maximal oxygen uptake (VO_2max) and maximum running speed duration at maximal oxygen uptake ($TlimVO_2max$), through field trial versus laboratory test, indicates the different training levels of athletes.

Secondary hypothesis 2: the anthropometrical indicators correlate with maximal oxygen uptake and maximum running speed duration at maximal oxygen uptake.

Secondary hypothesis 3: using data regarding the evaluation of vVO_2max to calculate the intensity of training efforts, plan the running distances and durations, and individualise them per group of players, leads to an increase in maximal oxygen uptake.

General hypothesis 2 of the study is as follows: the measurement of biochemical, sanguine, and salivary indicators points out how the body responds biochemically to the metabolic stress specific to effort at maximal oxygen uptake.

Secondary hypothesis 1: the comparative statistical analysis of biochemical, sanguine, and salivary indicators, sampled before, at rest, and after reaching VO_2max, indicates their acute modifications. Secondary hypothesis 2: the comparative statistical analysis of biochemical, sanguine, and salivary indicators sampled before, at rest, and after reaching VO_2max can determine specific correlations between the biochemical works sampled from the blood and saliva.

The statistics of results within the primary study

Table 7 - The statistics of findings obtained in anthropometrical measurements, testing the force of the lower limbs, the speed and mobility of the spine

	Mean	**Standard deviation**	**Skewness**	**Kurtosis**	**Minimal**	**Maximal**
Height (cm)	178.125	5.328	0.129	-0.885	170	188
Weight (kg)	71.244	8.899	-0.922	0.612	50.10	83.70
BMI (m^2/kg^{-1})	22.446	2.582	-1.058	1.310	16.359	26.128
Muscle_Mass (%)	41.888	2.082	-0.492	0.233	37.70	45.60
Body_Fat(%)	15.725	4.224	0.187	0.579	7.60	23.90
Squat-Jump (cm)	35.094	4.339	0.554	-0.047	29.10	44.70
CountermoveJump(cm)	36.362	4.559	0.518	1.191	28.10	47.30
Free Jump (cm)	39.875	6.526	0.669	-0.048	29.70	53.40
5 m (sec)	1.044	0.038	-0.181	-1.032	0.980	1.10
10 m (sec)	1.722	0.103	-0.451	-0.118	1.50	1.88
20 m (sec)	2.995	0.107	0.663	-0.637	2.85	3.20
Spine_mobility (cm)	-7.188	10.895	1.926	4.455	-18.0	25.0

Table 8 – The statistics of results for VO_2max, $TlimVO_2max$, and $HrTlimVO_2max$, field and laboratory

	Mean	**Standard deviation**	**Skewness**	**Kurtosis**	**Minimal**	**Maximal**
VO_2max ($ml^{-1}kg^{-1}$)	58.522	2.758	0.824	-0.360	55.30	64.30

VAM_lane (km/h)	16.406	0.773	0.813	-0.379	15.50	18.0
Hr_max_VAM (b/min)	201.733	16.786	1.153	0.186	185.0	238.0
400 m (min, sec)	1.27	0.045	-1.028	0.103	1.17	1.32
TlimVO$_2$max (sec)	219.222	47.656	1.418	2.026	154.0	340.0
HrTlimVO$_2$max (b/min)	195.563	16.793	0.058	-0.778	166.0	223.0
VO$_2$max_lab (ml^{-1}kg^{-1})	56.822	2.549	0.392	-0.505	52.30	61.7
HR_VO$_2$max_lab (b/min)	187.278	3.754	0.634	-0.357	182.0	195.0
TlimVO$_2$max_lab (sec)	201.944	36.143	1.859	3.098	160.0	300.0
HrTlimVO$_2$max_lab(b/min)	196.667	7.806	0.390	-0.788	185.0	211.0

Table 9 – T-test analysis for VO$_2$max, TlimVO$_2$max, and HrTlimVO$_2$max

Measure 1	Measure 2	t	Df	p	Cohen's d
VO$_2$max(ml.min^{-1}kg^{-1})	VO$_2$max_lab (ml.min^{-1}kg^{-1})	9.100	17	< .001	2.145
TlimVO$_2$max (sec)	TlimVO$_2$max_lab (sec)	3.807	17	0.001	0.897
Hr_max_VAM(b/min)	Hr_VO$_2$max_lab (b/min)	3.631	14	0.003	0.938
HrTlimVO$_2$max (sec)	HrTlimVO$_2$max_lab(sec)	-0.204	15	0.841	-0.051

To provide a better explanation for these aspects regarding the importance of reifying the results of evaluations, I mention the difference in the training intensity of the players who obtained the minimum (VO$_2$max=55,300 ml.min^{-1}kg^{-1}; VAM=15,5 km/h) and the maximum (VO$_2$max=64,300 ml^{-1}kg^{-1}; VAM=18 km/h) scores to the VAM and VO$_2$max evaluations (Table 12).

Table 12 - The difference in the training intensity between two players with a different vVO$_2$max

Player	VO$_2$max / vVO$_2$max (VAM)	2'30" at 100% of the vVO2max	400 m at 110% of the vVO2max	20 sec at 120% of the vVO2max	15 sec at 130% of the vVO2max
A	55.300 ml.min^{-1}kg^{-1}; VAM=15,5 km/h	645 metres	85 sec (1'25")	103 metres	84 metres
B	64.300 ml.min^{-1}kg^{-1}; VAM=18 km/h	750 metres	73 sec (1'13")	120 metres	97 metres

Table 24 – Descriptive statistics for the values of VO_2max and initial and final VAM

Descriptive statistics

	VO_2max (initial) $ml.min^{-1}kg^{-1}$	VAM_lane (initial) km/h	VAM_lane (final) km/h	VO_2max (final) $ml.min^{-1}kg^{-1}$
Valid	18	18	18	18
Mean	58.522	16.406	16.983	60.583
Std. Deviation	2.758	0.773	0.659	2.369
Minimal	55.3	15.5	16	57.1
Maximal	64.3	18	18.5	66

The following Table features the statistics of biochemical indicators in blood and saliva: cortisol, amylase, DHEA-S, and lactate, after performing the student T-test (Table 26):

Table 26 - Paired Samples T-Test for cortisol, amylase, DHEA-S, and lactate

Paired Samples T-Test

						95% CI pt Cohen's d	
Measure 1	**Measure 2**	**t**	**df**	**p**	**Cohen's d**	**Minimal**	**Maximal**
Cortisol_SER_R	- CORTISOL_SER_E	1.296	18	0.211	0.297	-0.166	0.753
DHEA_SER_R	- DHEA_SER_E	-1.080	18	0.295	-0.248	-0.701	0.212
Amylase_SER_R	- Amylase_SER_E	-2.455	18	0.025	-0.563	-1.042	-0.071
Lactate_R	- Lactate_E	-12.500	18	< .001	-2.868	-3.892	-1.828
Cortisol_S_Rest	- Cortisol_S_10min	1.081	18	0.294	0.248	-0.212	0.702
Cortisol_S_Rest	- Cortisol_S_30min	2.016	18	0.059	0.463	-0.017	0.931
Cortisol_S_10min	- Cortisol_S_30min	2.172	18	0.043	0.498	0.014	0.970
DHEA_S_Rest	- DHEA_S_10mins	-1.072	18	0.298	-0.246	-0.699	0.214
DHEA_S_Rest	- DHEA_S_30min	0.303	18	0.765	0.070	-0.382	0.519
DHEA_S_10mins	- DHEA_S_30min	2.212	18	0.040	0.507	0.022	0.980
Amylase_S_Rest	- Amylase_S_10min	-2.768	18	0.013	-0.635	-1.122	-0.133
Amylase_S_Rest	- Amylase_S_30min	-0.833	18	0.416	-0.191	-0.642	0.265
Amylase_S_10min	- Amylase_S_30min	2.349	18	0.030	0.539	0.050	1.015

Conclusions

Following the study, collection, analysis, interpretation of the findings, and assessment of the research hypotheses, the following conclusions can be drawn:

The findings of the preliminary study show that the training based on practising with the ball, focusing on technical and tactical exercises performed in the competitive period, did not increase the level of maximal oxygen uptake among football players. However, the preliminary study proves that this method ensures the maintenance of maximal oxygen uptake in the competitive period.

Evaluating maximal oxygen uptake using laboratory tests or field trials ensures that we consider the individual aerobic performance level and the possibility of planning the volume or intensity of physical effort to improve aerobic resistance based on scientific, accurate, and applicable reference points within a football team.

VO_2max assessed in the laboratory correlates with that in the field. However, VO_2max evaluated in the laboratory is statistically significantly lower than VO_2max assessed in the field. The same thing occurred concerning TlimvVO_2max.

Maximal oxygen uptake – assessed in the laboratory or field – does not correlate with the anthropometrical indicators but correlates positively with the jump score. In addition, the study highlights a positive correlation between the speed score and the jump score. TlimvVO_2max does not correlate with the anthropometrical indicators.

Using the results regarding the evaluation of vVO_2max to calculate the intensity of training efforts, plan the running distances and durations, and individualise them per group of players led to an increase in maximal oxygen uptake, among football players, in the competitive period.

Concerning the acute modifications of cortisol, the Anova results could be interpreted in that cortisol's blood works are more relevant than the saliva values. At the same time, upon analysing Pearson's correlation index performed for the values recorded by cortisol in the blood versus the saliva, I found a strong correlation between the response of blood and saliva cortisol. This aspect could represent an argument for collecting biological samples from the saliva, not the blood, for other studies. In addition, the fact that the cortisol level did not increase post-effort in the blood or saliva (also found in other studies) can represent a hypothesis for further research investigations that could start from the idea that – concerning well-trained athletes – effort at VO_2max does not induce significant metabolic stress on the hypothalamus-hypophysis-adrenocortical axis.

The study does not show a correlation between the response to the effort of the salivary and blood DHEA-S. In addition, the significant modification of post-effort amylase and its higher level in the saliva compared to the value obtained in the blood after effort could represent an argument for future studies determining amylase to use saliva, not blood samples.

Perspectives and applicability range of research findings

The study findings – some published in scientific ISI journals or presented at international conferences – bring exciting data for the bibliography of the field to be used for future studies. Besides the clear reference points provided by the findings of the evaluations within the study, the thesis offers an original model for planning the specific means to train aerobic endurance among football players, demonstrating the importance of individualising the effort to develop maximal oxygen uptake. In addition, the software program designed to calculate the running times at a certain vVO_2max intensity is original and innovative. At the same time, a new element of the thesis is calculating a "speed score" index and a "jump score" correlated with the anthropometrical data and the maximal oxygen uptake. These data can represent highly applicable instruments helpful to practitioners in the field. The findings allow continuing studies to determine explicit references for practitioners. Namely, I refer to the individualisation of planning the training effort based on the physiological and biochemical biomarkers in the blood and saliva. The findings on cortisol and amylase offer favourable perspectives for future studies that would determine the utility and accuracy of using saliva, not blood samples. In addition, an exciting follow-up could be a study to establish the optimal level, before matches, of hormones like testosterone, endorphin, dopamine, or cortisol, in correlation with psychological factors like motivation, trust, self-esteem, and using both motor and cognitive techniques to bring them to optimal parameters.

Dissemination of the results

The publication of papers in scientific journals materialised the findings of the studies performed within the doctoral thesis.

Honceriu, C., Curpan, AS., Ciobica, A., Trus, C., Timofte, D. (2021). Connections between Different Sports and Ergogenic Aids-Focusing on Salivary Cortisol and Amylase. Medicina-Lithuania 2021, Volume 57, Issue 8, article Number 753, DOI10.3390/medicina57080753.

Honceriu, C., Pătrășcan, A. (2021). Study on TlimvVO$_2$MAX in soccer players. Sport și Societate, Vol. 21, nr. 1 (2021), p. 1-6.

Costache A.D, Leon-Constantin M.M, , Roca M., Mastaleru A., Anghel R.C., Zota I.M., Drugescu A., Costache I.I, Chetran A., Moisă S.A., Huzum B., Mitu O., Cumpăt C., **Honceriu C.,** Mitu F. (2022). Cardiac Biomarkers in Sports Cardiology. J. Cardiovasc. Dev. Dis. 2022, 9, 453. https://doi.org/10.3390/jcdd9120453

Costache, A.D., Roca, M., **Honceriu, C.**, Costache, I.I., Leon-Constantin, M.M., Mitu, O., Miftode, R.S, Mastaleru, A., Iliescu-Halitchi, D., Halitchi-Iliescu, C.O., Ion, A., Duca, S.T. Popa, D.M., Abalasei, B., Mocanu, V., Mitu, F. (2022). Cardiopulmonary Exercise Testing and Cardiac Biomarker Measurements in Young Football Players: A Pilot Study. Journal Of Clinical Medicine, Volume11, Issue10, Article Number 2772.

Costache A.D., Costache , I.I., Miftode, R.S., Stafie, C.S., Leon-Constantin, M.M., Roca, M., Drugescu, A., Popa, D.M., Mitu, O., Mitu, I., Miftode, L.I., Iliescu, D., **Honceriu, C.**, Mitu, F. (2021). Beyond the Finish Line: The Impact and Dynamics of Biomarkers in Physical Exercise—A Narrative Review. Journal of clinical medicine, 10, 4978. https://doi.org/10.3390/jcm10214978

Selective bibliography:

Acala, J.J., Roche-Willis, D., Astorino, T.A. (2020). Characterizing the heart rate response to the 4 x 4 interval exercise protocol. International journal of environmental research and public health. Vol. 17 Issue 14, Article Number: 5103, DOI: 10.3390/ijerph17145103.

Adaikina, A., Hofman, P.L., O'Grady, G.L., Gusso, S. (2020). Exercise Training as Part of Musculoskeletal Management for Congenital Myopathy: Where Are We Now? Pediatric Neurology, Vol. 104, Pages: 13-18. DOI: 10.1016/j.pediatrneurol.2019.10.008

Agrawal, I., Jha, S. (2020). Mitochondrial Dysfunction and Alzheimer's Disease: Role of Microglia. Front. Aging Neurosci, Vol 12, art.nr.252. doi.org/10.3389/fnagi.2020.00252.

Ahmadi, M.A., Ahmadi, F., Zar, A., Krustrup, P. (2018). Testosterone and cortisol response to acute intermittent and continuous aerobic exercise in sedentary men. Sport Sci. Health Volume: 14, Pages: 53-60.

Al Meshari, S. Z., Aldweesh, A. H. (2022). Correlation between salivary dehydroepiandrosterone sulfate (DHEA-S) levels and cervical vertebral maturation in Saudi individuals. The Saudi dental journal, 34 (5), 355–361. https: // doi.org/ 10.1016/j.sdentj.2022.05.001

Bekris, E., Mylonis, L., Gioldasis, A., Gissis, I., Kombodieta, N. (2016). Aerobic and anaerobic capacity of Professional soccer players in annual macrocycle. J. Phys. Educ. Sport, 16, 527.

Budijanto, R. K. (2020). Aerobic Vs. Anaerobic Training to Increase VO2max Soccer Players. Int. Journal of Multicultural and Multireligious Understanding, Vol. 7, No. 9, p.383-387.

Honceriu, C., Pătrășcan, A. (2021). Study on TlimvVO$_2$MAX in U16 soccer players. Sport și Societate, Vol. 21, nr. 1, p. 1-6.

Parmar, A., Jones, T.W., Hayes, P.R. (2021). The dose-response relationship between interval-training and VO2max in well-trained endurance runners: A systematic review. Journal of Sport Sciences, Volume: 39, Issue: 12, Pages: 1410-1427.

Pavlović, R., Mihajlović, I., Radulović, N., Gutić, U. (2021). Functional capabilities of runners: estimation of Maximal oxygen consumption (VO2max) and heart rate percentage (%HRmax) based on running results. Adv Health Exerc, 1(1): 1-6.

Riboli, A., Rampichini, S., Cè, E., Limonta, E., Borrelli, M., Coratella, G., Esposito, F. (2021). Training status affects between-protocols differences in the assessment of Maximal aerobic velocity. Eur J Appl Physiol. 2021; 121(11): 3083–3093.

Silva, A.F., Aghidemand, M.H., Kharatzadeh, M., Ahmadi, V.K.,Oliveira, R., Clemente, F.M., Badicu, G., Murawska-Ciałowicz, E. (2022). Effects of High-Intensity Resistance Training on physical fitness, hormonal and antioxidant factors: a randomized controlled study conducted on young adult male soccer players. Biology 2022, 11, 909.