The time limit of maintaining the running speed at VO$_{2\text{max}}$ (T$_{\text{lim}}$ VO$_{2\text{max}}$).
A comparative study between trained and untrained

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Abstract
Specialised literature is very rich in means evaluating of VAM or VO$_{2\text{max}}$ and methods of increasing this physical ability, yet poorer in assessing the limit time of maintaining it ($t_{\text{lim}}$VO$_{2\text{max}}$). $t_{\text{lim}}$VO$_{2\text{max}}$ is the running time that an athlete can maintain at VAM. This study assumes that it is possible that trained individuals achieve a $t_{\text{lim}}$VO$_{2\text{max}}$ greater than untrained individuals. 14 male persons were involved in this study; they were divided into two groups: trained and untrained. VAM evaluation was done by using the VAMEVAL test. The evaluation of $t_{\text{lim}}$VO$_{2\text{max}}$ was done by using the VAMEVAL soft. The results of the study refute the research hypothesis, Group B, that was made up of subjects with a lower VO$_{2\text{max}}$, obtained an average $t_{\text{lim}}$VO$_{2\text{max}}$ better than group A, group that consists of athletes and better VO$_{2\text{max}}$ subjects.

Key words: VO$_{2\text{max}}$, $t_{\text{lim}}$VO$_{2\text{max}}$, trained, untrained

Rezumat
Literatura de specialitate este foarte bogată privind modalităţile de evaluare a VAM sau VO$_{2\text{max}}$ şi metodele de creştere a acesteia capacitate fizică însă mai săracă în aprecieri asupra timpului limită de menţinere a acesteia ($t_{\text{lim}}$VO$_{2\text{max}}$). $t_{\text{lim}}$VO$_{2\text{max}}$ reprezintă timpul de alergare pe care un sportiv îl poate menţine la VAM. Prezentul studiu pleacă de la ipoteza că este posibil ca persoanele antrenate să realizeze un $t_{\text{lim}}$VO$_{2\text{max}}$ mai mare decât persoanele neantrenate. La studiu au participat 14 persoane de gen masculin care au fost împărţite în două grupe: antrenaţi şi neantrenaţi. Evaluarea VAM a fost realizată cu ajutorul testului VAMEVAL. Evaluarea $t_{\text{lim}}$VO$_{2\text{max}}$ a fost realizată cu ajutorul soft-ului VAMEVAL. Rezultatele studiului infirmă ipoteza cercetării, Grupa B, cea care a avut în componenţă subiecţii cu un VO$_{2\text{max}}$ mai mic, a obţinut o medie $t_{\text{lim}}$VO$_{2\text{max}}$ mai bun decât grupa A, grupă care are în componenţă subiecţii mai sportivi şi cu un VO$_{2\text{max}}$ mai bun.

Cuvinte cheie: VO$_{2\text{max}}$, $t_{\text{lim}}$VO$_{2\text{max}}$, antrenaţi, neantrenaţi

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Introduction
The maximum oxygen use (VO₂max) can be considered as an important indicator of cardiorespiratory aptitude in the endurance effort or, in other words, of the aerobic capacity to effort. (1,8,11)

If in rest VO₂ is almost the same for both trained and untrained individuals (250-300 ml/min), it tends to decrease in the case of the trained ones, in submaximal effort, for the same level of effort. This indicates an improvement in metabolic efficiency and perhaps, in particular, in biomechanical efficiency, trained athletes perform the same move with greater ease and therefore less energy consumption. (2). In addition, body weight may play an important role in improving the making of the movements and in a more effective effort metabolism. (14)

In maximal effort, we refer to maximum oxygen consumption (VO₂max). The increase of VO₂max is considered to be a metabolic adaptation since it involves both the adaptation of the respiratory and cardiovascular and blood system. (2, 13)

The aerobic type of training increases VO₂max value with up to 50%, depending on the intensity, volume and even complexity of the effort, as well as on the training level of the athlete. Thus, in the case of an untrained athlete, the growth percentage of VO₂max will be higher than in the case of an athlete who, through training, has already developed this parameter. (9) VO₂max cannot exceed a certain, biological-hereditary limit no matter how an the extent to which an athlete would train. Most studies show an increase in VO₂max, following a training program between 15 and 25%. (3,4,8,15)

The increase in VO₂max is obvious in nine to ten weeks of training, continuing to go up, but at a slower rate until the biological-hereditary limit. (10)

The maximal aerobic speed (VAM or vVO₂max) represents the running speed at which the athlete reaches VO₂max, and is measured in m/s or km/h.

This has been scientifically proven by Leger and Mercier (1983) [6], the following formula showing the correlation between VAM and VO₂max:

\[ \text{VO}_2\text{max} \ (\text{ml.kg}^{-1}.\text{min}^{-1}) = \text{VAM} \ (\text{km/h}) \times 3.5 \]

or,

\[ \text{VAM} \ (\text{km/h}) = \frac{\text{VO}_2\text{max} \ (\text{ml.km.min}^{-1})}{3.5} \]

The intensity and volume of training are very important in increasing VO₂max, these two parameters must be carefully correlated in planning, relying on the evaluation of vVO₂max or on the workload in watts, where the athlete reaches the aerobic or anaerobic effort limit. (14) Thus, the intensity of the effort, gradually planned in the training program, must be between 90-130% of VO₂max (7, 9)

Referring to efforts, we must highlight the importance of knowing tlimVO₂max value (time limit of maintaining the effort to vVO₂max). It is known that tlimVO₂max is in the range of 5-8 minutes. (5, 15)

The thesis of the research paper
Specialised literature is very rich in means evaluating of VAM or vVO₂max and methods of increasing this physical ability, yet poorer in assessing the limit time of maintaining it (tlimVO₂max). tlimVO₂max is the running time that an athlete can maintain at VAM. This study assumes that it is possible that trained individuals achieve a tlimVO₂max greater than untrained individuals.

Materials and methods
Basically, the study aims at achieving first the VAM evaluation of a number of 14 male persons, 7 of them being trained in endurance efforts, 7 untrained. In the second part, the study aims at evaluating the tlimVO₂max of the 14 subjects and calculating possible differences in percentages.

14 male subjects perform a field test to assess maximal aerobic speed (VAM). Seven of the subjects perform aerobic workout and exercise regularly, the other seven subjects are people who practice light physical activities from time to time.

The evaluation of the VAM was carried out using the VA(M)EVAL test (5), while calculating the distances and the running time for the tlimVO₂max evaluation was carried out by using the VAMEVAL soft. (5)

In the second stage, all 14 subjects perform a run at 100% of VAM, each subject having to maintain a running pace as long as possible.

The third stage of the research involved the analysis and interpretation of the results.
The protocol for the VAM evaluation through field test
The VAMEVAL test, designed in 1983 by Professor Luc Leger of the University of Montreal and Professor Georges Cazorla, University of Bordeaux, is a field test that assesses VO\textsubscript{2}max and maximal aerobic speed (VAM or VMA). (5)

The subjects of the research
14 male subjects, aged 18 to 35, divided into two groups.
- Group A consists of 7 subjects who practise physical exercise regularly.
- Group B consists of 7 subjects performing light exercise sporadically.

Results and discussions
The following table (table 1) shows some statistical indicators: arithmetic average, amplitude and standard deviation.
One can notice a higher VAM value of about 1 km / h for group A, 15.7 km / h compared to 15 km / h in group B. This indicates a higher aerobic exercising capacity in group A subjects than group subjects. From the point of view of the homogeneity of the two groups, there is a greater homogeneity in the results of group B subjects.
Interestingly, in regard to \( t_{\text{lim}}\text{VO}_2\text{max} \), the results obtained from the research are somewhat surprising and contradictory to the hypothesis of the paper. Thus, the arithmetic average of \( t_{\text{lim}}\text{VO}_2\text{max} \) of group B is higher than that of group A. If we make a simple calculation of the percentage difference between the two arithmetic averages, we record the percentage difference of 1.96% in group B. We also mention that group B subjects are those who practise physical activities less often than those in group A.
Theoretically speaking, the fitter subjects with better VO\textsubscript{2}max should have obtained better results in the effort test of \( t_{\text{lim}}\text{VO}_2\text{max} \). This did not happen and practically, the subjects with a lower VO\textsubscript{2}max obtained a better average of \( t_{\text{lim}}\text{VO}_2\text{max} \).
The results obtained in this research with regard to \( t_{\text{lim}}\text{VO}_2\text{max} \) have been obtained by other authors as well (4, 5, 10, 15) who investigated \( t_{\text{lim}}\text{VO}_2\text{max} \). We found no studies to conduct a comparative survey of \( t_{\text{lim}}\text{VO}_2\text{max} \) in trained and untrained subjects.
For a more accurate and objective interpretation of the results, we believe that monitoring the heart rate during the exercise would have provided important additional data to explain the evolution and the dynamics of the effort as well as the recorded results.
The results obtained after VAM assessment through a field test by the subjects in Group A and the statistical calculation are presented in table 2.
The results obtained after VAM assessment through a field test by the subjects in Group B and the statistical calculation are presented in table 3.

| Table 1. Statistics of the results of the two groups |
|---------------------------------|---------|---------|---------|---------|
|                                | Level   | VAM (km/h) | \( t_{\text{lim}}\text{VO}_2\text{max} \) |
|                                | Group A | Group B   | Group A   | Group B |
| Arithmetic average            | 16      | 14       | 15.7      | 15      |
| Amplitude                      | 8       | 6        | 3.5       | 2.5     |
| Standard deviation             | 2.58    | 2.16     | 1.1       | 1.1     |
|                                |         |          | 0'65"     | 0'65"   |

| Table 2. The results recorded by group A and statistical indicators |
|------------------|---------|---------|
| Subject no.1     | Level   | VAM (km/h) |
| Subject no.2     | 15      | 15.5      |
| Subject no.3     | 18      | 17        |
| Subject no.4     | 11      | 13.5      |
| Subject no.5     | 17      | 16.5      |
| Subject no.6     | 16      | 16        |
| Subject no.7     | 19      | 17.5      |
| Arithmetic average (X)| 16     | 15.7      |
| Amplitude        | 8       | 3.5       |
| Standard deviation| 2.58    | 1.1       |

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**Conclusions**
Following the study and the results, we may draw the following conclusions:

Group B, which consists of the subjects with a lower VO$_{2}$max, obtained an average a tlimVO$_{2}$max better than that of group A group that consists of fitter subjects, with better VO$_{2}$max. These results do not confirm the initial hypothesis of this study, namely that it is possible that the trained subjects obtain a higher tlimVO$_{2}$max than untrained individuals. It is possible that a lower vO$_2$max determine a tlimVO$_{2}$max due to greater efficiency of the cardiovascular system as well as better use of O$_2$ in muscles.

Therefore, we believe that, for a more accurate and objective interpretation of results, monitoring heart rate during exercise in conjunction with an analysis of biochemical indicators and / or O$_2$ consumption in muscles would have brought us important additional data to explain the evolution and dynamics of effort and the recorded results.

**References**

**Table 3.** The results recorded by group B and statistical indicators

<table>
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<tr>
<th>Subject no.</th>
<th>Level</th>
<th>VAM (km/h)</th>
<th>tlimVO$_{2}$max</th>
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<td>5'</td>
</tr>
<tr>
<td>Subject no.4</td>
<td>17</td>
<td>16.5</td>
<td>5'20”</td>
</tr>
<tr>
<td>Subject no.5</td>
<td>11</td>
<td>13.5</td>
<td>6'45”</td>
</tr>
<tr>
<td>Subject no.6</td>
<td>14</td>
<td>15</td>
<td>5'30”</td>
</tr>
<tr>
<td>Subject no.7</td>
<td>16</td>
<td>16</td>
<td>5'</td>
</tr>
</tbody>
</table>

**Graph 1.** The arithmetic average of the results recorded by the two groups