# LEVEL OF VO2 MAX CAPACITY VOLLEYBALL PLAYERS

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**Keywords:**
- volleyball
- oxygen uptake
- beep test

**Abstract:**
The aim of the study was to evaluate the level of maximal aerobic capacity of volleyball players from the AZS UR Rzeszów club. The examinations were performed during the 2014/2015 season. The study evaluated maximal oxygen uptake (Vo2max) in individual players from the team. The maximum oxygen uptake was computed based on four formulas. The multi-level 20m shuttle test (the Beep test) was used to measure the running speed. The results were interpreted using the tables with the number of completed levels. The standard deviation was 1.92, with mean running speed of 12.15km/h and mean number of sections covered by the players being 67. The examinations conducted by the authors were aimed to provide answers to the following questions:
1. Is there a difference in the level of Vo2max for the four different formulas?
2. Is there a strong correlation between the results of the maximal oxygen uptake computed for the four different formulas?

## INTRODUCTION

High sports skill level in volleyball requires the adequate level of physical fitness. Effectiveness of the basic technical actions performed during the game is essential in modern volleyball. The competitive load the volleyball players are exposed to involves a substantial energy expenditure. It has an effect on the elevated work intensity of the cardiovascular, respiratory, muscular and nervous systems. Exercise during a match occurs at insufficient oxygen supply and forces body to utilize anaerobic energy systems. Rests between individual actions do not allow for full recovery. However, there are also conditions for activation of the aerobic system that accelerate recovery during the match [Grządziel 2012]. During intensive phases of the game, oxygen debt reaches 10 l, lactic acid levels are 250 mg% and minute ventilation reaches 120-130 l/min. The heart rate recorded in various forms of games changed over the broad range of values, which reflects the variable character of the exercise and dominance of the aerobic-anaerobic energy systems. The telemetric observations revealed that the aerobic system was used in around 10%, mixed systems - from 40% to 80%, and, the anaerobic system - from 10 to 60% [Kielak 1999].

These high exercise parameters of the competitive load require using the similar and sometimes higher training load which would be conducive to the process of functional adaptation to game requirements.

High level of maximal oxygen uptake (Vo2max), also termed maximal aerobic capacity, is critical for the achievement of high physical capacity of human body. It determines cardiorespiratory endurance [Wilmore, Costill 2004]. Maximal oxygen uptake varies from person to person and depends on many factors, such as gender, age or level of fitness. Vo2max represents the measure that allows for predicting the body response to a long-term exercise and ability of both healthy and ill people to perform exercise. At rest, oxygen

consumption reaches an average of 250-300 ml/min. Each body movement and each smallest physical activity improves oxygen consumption so that it is adequate for the work performed. After completion of physical activity, maximal oxygen consumption ranges from 3 l/min to 6 l/min. The amount of oxygen that an athlete needs depends in particular on the athlete's level and exercise intensity. It is training and regular exercise that improve the economics during oxygen consumption [ Żołądź 2002].

Trained people are characterized by better exercise economy and more efficient oxygen use. The people with higher physical capacity require less energy expenditure at the same level of exercise. Physical capacity is a measure which means the amount of oxygen the body has to use to perform a specific work.

## STUDY AIM

The aim of the study was to evaluate physical capacity in a group of 10 volleyball players from the AZS URZ team. The examinations were performed during the 2014/2015 season. The study evaluated maximal oxygen uptake (Vo2max) in individual players from the team.

The results were interpreted using the tables with the number of completed levels. The standard deviation was 1.92, with mean running speed of 12.15km/h and mean number of sections covered by the players being 67.

The examinations conducted by the authors were aimed to provide answers to the following questions:

1. Is there a difference in the level of Vo2max for the four different formulas?
2. Is there a strong correlation between the results of the maximal oxygen uptake computed for the four different formulas?

## MATERIAL AND METHODS

This study used the experimental and statistical research methods.

The multi-level 20m shuttle test (the Beep test) was used to measure the running speed. The test is used to measure cardiorespiratory endurance, coefficients of correlation and maximal oxygen uptake (Vo2max). The test participants perform a 20m shuttle run at the speed that increases gradually at 1-minute intervals, controlled by the auditory signal. The results were interpreted using the tables that specify the number of completed levels, gender and age [ Léger, Lambert 1982].

Before the test, the athletes were informed about the study aim, procedures and the possibility of stopping the examinations and withdrawal from the participation at any moment. The measurements were recorded in the evening from 7:30 pm and 8:30 pm. Study participants performed a multi-level 20m shuttle run test (the Beep test). The table below illustrates the details of the study group.

Mean age of the volleyball players studied was 21.5 years, with the mean result of the Beep test in the group being 8.63. The standard deviation was 1.92, with mean running speed of 12.15km/h and mean number of sections covered by the players being 67.

Maximal oxygen uptake was computed using four formulas:

1. According to the examinations in the Canadian population [Léger et.al 1988]
    a. For the age of over 18 years: Vo2max = -24.4 + 6.0 x P
2. According to the examinations in the Canadian population [Léger, Gadoury 1989]
    a. In adults: Vo2max = -32.678 + 6.592 x P
3. According to the examinations in the Japanese population [Matsuzaka et al. 2004]
    a. For the age of 18-23 years: Vo2max = -22.3 + 5.98 x P
    b. For the age of 18-23 years: Vo2max = 28.1 + 0.274 x L

P- maximal running speed (in the last level completed); L- total number of 20m sections covered.

**Table 1.** Mean values of select parameters of the study group

| Study participants | Age [years] | Result | Max. running speed [km/h] | Number of sections |
|---|---|---|---|---|
| **Participant 1** | 20 | 9.3 | 12.5 | 75 |
| **Participant 2** | 21 | 10.7 | 13 | 79 |
| **Participant 3** | 19 | 6.5 | 11 | 46 |
| **Participant 4** | 19 | 10 | 13 | 83 |
| **Participant 5** | 20 | 11.7 | 13.5 | 101 |
| **Participant 6** | 22 | 8.3 | 12 | 64 |
| **Participant 7** | 23 | 6.1 | 11 | 42 |
| **Participant 8** | 25 | 9.6 | 12.5 | 78 |
| **Participant 9** | 28 | 7.1 | 11.5 | 52 |
| **Participant 10** | 18 | 7 | 11.5 | 51 |
| **Mean** | 21.5 | 8.63 | 12.15 | 67.1 |
| **Standard deviation** | 3.1 | 1.92 | 0.88 | 19.14 |

*Source*: Author's own study, 2015

Statistical analysis of parameters used the Shapiro-Wilk test and the Student's t-test for dependent samples. Furthermore, the Pearson's linear correlation coefficient that determines the correlation between variables was also used. In the beginning, the Shapiro-Wilk test was used to verify whether the distribution of the variables is similar to normal distribution. The analyses revealed that the distribution of each variable was normal, which suggested the use of parametric tests. Therefore, further comparisons were based on the Student's t-test. Statistical analysis was performed using Statistical 10.0 software (StatSoft Inc., Tulsa, USA) at the level of significance set at 0.05 [Ostasiewicz i in.1999].

## RESULTS

In order to provide answers to the research questions, the formulas I to IV were used for computation of the maximal oxygen uptake for the results presented in Table 1. The results of these computations are shown in Table 2.

Formulas:

I. $Vo2max = -24.4 + 6.0*P$
II. $Vo2max = -32.678 + 6.592*P$
III. $Vo2max = -22.3 + 5.98*P$
IV. $Vo2max = 28.1 + 0.274*L$

where:
P- maximal running speed (in the last level completed);
L- total number of 20m sections covered.

Comparison of the mean results obtained in the study group reveals that the differences in maximal oxygen uptake for the formulas used are not substantial. Therefore, statistical analysis was used to determine whether the differences were statistically significant at the significance level set at $p = 0.05$.

**Table 2**. Maximal oxygen uptake calculated using four formulas for each player

| | **Formula I** | **Formula II** | **Formula III** | **Formula IV** |
|---|---|---|---|---|
| **Participant 1** | 50.6 | 49.7 | 52.5 | 48.7 |
| **Participant 2** | 53.6 | 53 | 55.4 | 49.7 |
| **Participant 3** | 41.6 | 39.8 | 43.5 | 40.7 |
| **Participant 4** | 53.6 | 53 | 55.4 | 50.8 |
| **Participant 5** | 56.6 | 56.3 | 58.4 | 55.7 |
| **Participant 6** | 47.6 | 46.4 | 49.4 | 45.6 |
| **Participant 7** | 41.6 | 39.8 | 43.3 | 39.6 |
| **Participant 8** | 50.6 | 49.7 | 45 | 49.4 |
| **Participant 9** | 44.6 | 43.3 | 47 | 42 |
| **Participant 10** | 44.6 | 43.1 | 46.5 | 42.1 |
| **Mean** | 48.5 | 47.4 | 49.6 | 46.4 |
| **Standard deviation** | 5.3 | 5.82 | 5.45 | 5.25 |

*Source*: Author's own study, 2015

**Tab. 3.** The results of the Shapiro-Wilk, significance level set at p = 0.05

| **Variable** | **p** |
|---|---|
| **Formula I** | 0.4519 |
| **Formula II** | 0.4762 |
| **Formula III** | 0.3106 |
| **Formula IV** | 0.4930 |

*Source*: Author's own study, 2015

The results presented in the table above show that the variables analyzed have the distribution similar to normal distribution. This result allows for the use of the Student's t-test for the next step of the analysis.

**Tab. 4.** The results of the analysis using the Student's t-test for dependent samples, significance level set at p = 0.05

| **Variables** | **p** |
|---|---|
| **Formula I vs. Formula II** | 0.6665 |
| **Formula I vs. Formula III** | 0.6411 |
| **Formula I vs. Formula IV** | 0.3919 |
| **Formula II vs. Formula III** | 0.3880 |
| **Formula II vs. Formula IV** | 0.6971 |
| **Formula III vs. Formula IV** | 0.1966 |

*Source:* Author's own study, 2015

Results presented in Table 4 showed that the values are greater than p = 0.05, which means that there are no reasons for rejecting the zero hypothesis which assumes that the values of maximal oxygen uptake calculated using the four formulas differ from each other. These results can be confirmed using the Pearson's r correlation (Tab. 5).

**Tab. 5.** Pearson's r correlation coefficients

| | **Formula I** | **Formula II** | **Formula III** | **Formula IV** |
|---|---|---|---|---|
| **Formula I** | 1.00 | 1.00 | 0.90 | 0.98 |
| **Formula II** | 1.00 | 1.00 | 0.90 | 0.98 |
| **Formula III** | 0.90 | 0.90 | 1.00 | 0.86 |
| **Formula IV** | 0.98 | 0.98 | 0.86 | 1.00 |

*Source:* Author's own study, 2015

Level of linear correlation between combinations of formulas I - IV ranges from 0.86 to 1, which means that there is a strong correlation between the results obtained form the formulas used.

## CONCLUSIONS

The aim of this study was to determine differences in the level of Vo2max calculated for four different formulas and to verify the correlation between the results.

The examinations were performed in a group of 10 athletes by means of a multi-level shuttle test (the Beep test), the Shapiro-Wilk test, the Student's t-test and the Pearson's r correlation. The results revealed a strong correlation between the results obtained for the formulas used. Presence of statistically significant differences between the results obtained for four different formulas was also found.

The following conclusions were drawn based on the results:

1. There are no statistically significantly differences between the results obtained for four different formulas.
2. There is a strong correlation between the results obtained from the formulas.
3. Any of the Formulas I to IV analyzed in the study can be used to compute Vo2max.

## LITERATURE

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