International Journal of Physical Education, Sports and Health 2018; 5(2): 187-191


**P-ISSN:** 2394-1685
**E-ISSN:** 2394-1693
Impact Factor (ISRA): 5.38
IJPESH 2018; 5(2): 187-191

www.kheljournal.com
Received: 03-01-2018
Accepted: 04-02-2018

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# Development of linear models for estimating maximal oxygen uptake ($VO_2$ max.) of Kashmiri male youth (Habitat of high altitude)

**Sajjadh Ahmad Bhat and Dhananjoy Shaw**

**Abstract**
The aim of the study was to develop linear models for estimating Maximal Oxygen Uptake ($VO_2$ max.) of male youth habitat of Kashmir. The study was conducted on two hundred forty two healthy male youth of Kashmir valley (attitude: 6070 feet/1850 meters). The age of the subjects ranged from 18 to 23 years. The youth were administered with submaximal bench step test (American College of Sports Medicine Protocol) to determine the $VO_2$max. (dependent variable) by plotting HR-workload combinations calculated by Karvonen heart rate reserve method. Data was collected using Cardio-Sport heart rate monitor and step test protocol. The selected independent variables were Age, Body weight in kilograms (B.Wt.), Height in centimeters (Ht.), Resting Heart Rate (RHrest) , Target Heart Rate (THR), Maximal Heart Rate (HRmax.) , Heart Rate at Two minutes of step testing with cadence 15 steps/min (ExHR2), Heart Rate at Four minutes of step testing with cadence 20 steps/min (ExHR4) , Heart Rate at Six minutes of step testing with cadence 30 steps/min (ExHR6), recovery heart rate at one minutes of rest (RcvHR1), recovery heart rate at two minutes of rest (RcvHR2) and recovery heart rate at third minute of rest (RcvHR3), (As per the formula advocated by American College of Sports Medicine). The collected data was computed with mean, standard deviation, correlation matrix, and linear regressions for deriving linear models using SPSS. The study concluded with the development of ten independent linear models among which model number six (M6) was found to be the best model for estimating VO2 max. of Kashmiri youth (habitat of high altitude) with high degree of power of prediction.

**Keywords:** Maximal oxygen consumption, heart rate, step testing, high altitude, aerobic fitness, multiple correlation, regression analysis, linear models

## Introduction
$VO_2$max. also known as maximal oxygen consumption, maximal oxygen uptake, peak oxygen uptake or maximal aerobic capacity is the maximum rate of oxygen consumption as measured during incremental exercise, most typically on a motorized treadmill or on a bench step test (Dlugosz 2013) [6]. Maximal oxygen consumption reflects the aerobic physical fitness of the individual and is an important determinant of their endurance capacity. The name is derived from V = volume, $O_2$ = oxygen, max. = maximum.
$VO_2$max is expressed either as an absolute rate in (for example) liters of oxygen per minute (L/min) or as a relative rate in (for example) millilitres of oxygen per kilogram of body mass per minute (e.g. ml/kg/min). The latter expression is often used to compare the performance of endurance sports athletes. However, $VO_2$ max generally does not vary linearly with body mass. (Wikipedia, July 2017) [15].
$VO_2$max is the very important determinant of cardio-respiratory fitness and aerobic performance.$VO_2$ max (ml/min/kg) is a measure of the maximum amount of oxygen that one use during intense physical activity. This measurement determines fitness level by calculating how efficiently cells use oxygen for energy (Tipton, 1977) [5]. There are several methods one can use to measure $VO_2$ max, but many require sophisticated equipment such as a treadmill or a specially calibrated exercise cycle with calorimetry/ spirometry /gas analyzer. The step test with heart rate recordings is quickest, easiest and safest as well as feasible way to measure ones $VO_2$ max for basic calculation after taking in consideration the Karvonen formula for a step testing protocol and sub maximal exercise heart rate (Practical Math for Health Fitness

Professionals, (1996). It is postulated that appropriate regression models will be a step advance for estimating $VO_2$ max. for Kashmiri youth in forms of feasibility.

Heart rate is the number of cardiac contractions in one minute. The number of contraction range from 60-80 bts.min. The rate and intensity of the cardiac contractions is affected by exercise, long term training, age, sex, disease, stress, environmental temperature, altitude etc. However 72 beats per minute (bts/min) in is generally considered as a normal heart rate, however a lower resting heart rate is recorded in trained individuals then that of untrained. Autonomic Nervous System controls the working of heart during exercise. It is known that increase in heart rate during mild to moderate level of exercise is due to withdrawal of Parasympathetic nervous system activity (PNS).The rise in heart rate during strenuous exercise is mediated through sympathetic activity. Although one of the hallmark of the endurance athlete is a slower heart rate at rest (Bradycardia).The lower heart rate may be caused by any combination of three factors, a reduction in the intrinsic rate of heart, decreased sympathetic tone and increased parasympathetic tone.

Resting bradycardia is a well-known phenomenon in endurance trained athletes or sportspersons, however the mechanism responsible for this phenomenon have not been conclusively elucidated. Other investigators suggested that an increased parasympathetic influence in the trained individuals is accounted for the resting bradycardia (Tipton, 1977) [5].

Given that the increase in heart rate during incremental exercise mirrors the increase in cardiac output, maximal heart rate is often interpreted as the upper ceiling for an increase in central cardiovascular function. Indeed, research for the last 100 years has demonstrated that heart rate does in fact have a maximal value; one that cannot be surpassed despite continued increases in exercise intensity or training adaptations.

The regular exercise leads to adoptive changes in cardiac, physical performance and oxygen uptake capacity. Physically trained individuals are found to have maximum oxygen uptake capacity than physically untrained ones (Heyward, 1997) [11]. The requirement or adaptation of VO2 Max. for different games and sports or physical activity are different. The developed regression models will be of great help for above requirements.

Recent research revealed that the Queens College step test provides a valid estimate of VO2max. Step test performance at 3800 meters was reduced by 11% compared to sea level, whereas no change was observed at 2040 meters. These data corroborate previous findings that indicate a threshold at which altitude adversely affects aerobic capacity (Tiaira Bates, 2015) [13].

Out of all the physiological conditions, exercise if of a strenuous nature, has the most powerful effect upon the blood pressure. B.P has been used as a strong measure for examining the functioning of CVS in the human body. It has been pointed out by many scientists that the increase and the decrease of the HR of well-trained subjects at the beginning and immediately after the beginning and immediately after the exercise are much faster and rapider than those of untrained subjects. In general, the BP and HR react greatly but slowly to exercise in untrained subjects, while the BP respond very little but the HR respond sharply to exercise in trained subjects.

"Recovery heart rate" refers to the heart’s ability to return to normal levels after physical activity. Fitness level and proper function of heart are measured by the recovery phase. A heart that is healthy will recover at a quicker rate than one that is not healthy or is not accustomed to regular exercise. If one’s heart does not recover in reasonable time, one may have a heart problem.

**First Minute of Recovery**

The first minute of recovery is the most crucial. After exercise, heart rate experiences an abrupt drop during the first minute. This recovery period can indicate fitness level and give an early warning of potential heart problems. In a recent study performed by the Cleveland Clinic Foundation classified a heart rate decrease of 12 beats or less in the first minute as abnormal. The study also reported that people with an abnormal decline in heart rate had a greater chance of mortality in the subsequent six years due to heart problems. (The New England Journal of Medicine, October (1999).

**Two-Minute Recovery**

The heart rate two minutes after exercise is referred to as the recovery heart rate. This is the most common measurement in determining cardiovascular fitness. To test for improvements, record the working heart rate during exercise, then record recovery heart rate at the two-minute mark. Subtract the two-minute recovery rate from the working heart rate to determine a baseline for improvement. For example, if working levels were 150 beats per minute and the two-minute recovery rate was 95, then 55 is the recovery heart rate.

Recovery heart rate is simply your pulse rate after exercise. Some fitness specialists refer to it as post-exercise heart rate. The pulse number is used for different reasons in different settings. Recovery heart rate is also used in popular fitness tests like the YMCA Submaximal Step Test**.** During the fitness assessment, an exerciser steps up and down on a 12-inch box at a rate of 24 steps per minute. The test lasts for three minutes. Recovery heart rate is measured for one full minute immediately following the test.

It is summarized that at altitudes over 5000 feet (1524 meters), the ability to perform physical work is decreased due to hypoxia (lowered $PO_2$). However, healthy high altitude dwellers show excellent adaptation to their environment. These adaptations are likely to be associated with altered gene expression as the expression of genes associated with vascular control and reactions to hypoxia have been found to be high in altitude dwellers (Appenzeller 2006) [1]. Blood volumes are larger in high altitude dwellers. This is due to a large packed cell volume whereas at sea levels plasma volume was found to be large. Probably as the result of the large blood volumes, tolerance to orthostatic stress was greater than that in sea-level residents (Claydon, 2005) [4].

The Kashmir Valley being at high altitude (6070 feet/1850 meters) with mountains around demands a great deal of physical efficiency to survive and to live a graceful and healthy life. Kashmiri has to perform best in different changing altitudes, time and again, with or without any acclimatization for the life and social requirements, because of the very nature of its geographical, political, social, administrative, vocational requirement/s. It has been observed that Kashmiri youth is a habitat of high altitude, but they interact with rest of India (low or variable altitude), whether it is games/sports (nationals, inter-university, senior nationals, junior nationals, rural nationals etc.) or cultural exchange programs, education or others. Hence, linear models for estimating $VO_2$max. and evaluating aerobic fitness suitable to Kashmiri youth becomes imperative.

The Purpose of the study was to develop linear models in regard to maximal oxygen uptake (VO2 max.) of high altitude

Kashmiri male youth, which will be useful for evaluation, grading, grouping and monitoring the aerobic fitness.

**Methodology**

The study was conducted on two hundred and forty two healthy male subjects of Kashmir valley (altitude: 6070 feet/1850 meters). The age of the subjects ranged from 17 to 23 years. The youth were administered submaximal bench step test to determine the VO2 max. by plotting HR-workload combinations calculated by Karvonen heart rate reserve method. The following supporting cardio-circulatory variables were selected for measurement of $VO_2$max: Resting Heart Rate (HRrest) , Target Heart Rate (THR) , Maximal Heart Rate (HRmax.) , Heart Rate at Two minutes of step testing with cadence 15 steps/min (ExHR2), Heart Rate at Four minutes of step testing with cadence 20 steps/min (ExHR4) , Heart Rate at Six minutes of step testing with cadence 30 steps/min (ExHR6), X:recovery heart rate at one minute of rest (ExHR6), recovery heart rate at two minutes of rest (RcvHR2) and recovery heart rate at third minute of rest (RcvHR3), (As per the method advocated by American College of Sports Medicine).

Submaximal exercise testing can be used for estimating $VO_2$max by taking advantage of linear relationship between heart rate responses and workload $VO_2$ values. This linear relationship was taken in consideration by plotting HR-workload combinations calculated by Karvonen heart rate reserve method. (Practical Math for Health Fitness Professionals, 1996).

The statistical analysis was mean, standard deviation, correlation matrix and linear regression for deriving linear models using SPSS.

**Findings**

**Table 1:** Descriptive Statistics of the selected variables of the subjects (High Altitude Kashmiri Male Youth)

| S.N0 | Variable Name | Symbol | Mean | S.D |
|---|---|---|---|---|
| 1 | Age (Years) | AGE | 18.75 | 1.01 |
| 2 | Body weight (Kgs) | BWT | 54.53 | 6.88 |
| 3 | Height (cms) | HGT | 171.97 | 6.02 |
| 4 | Maximal Oxygen Uptake(ml/kg/min) | $VO_2$max. | 53.20 | 5.11 |
| 5 | Resting Heart rate (bts/min) | HRrest | 63.26 | 10.10 |
| 6 | Heart rate at 2 mins of exercise (bts/min) | ExHR2 | 144.95 | 9.22 |
| 7 | Heart rate at 4 mins of exercise(bts/min) | ExHR4 | 174.68 | 10.86 |
| 8 | Heart rate at 6 mins of exercise(bts/min) | ExHR6 | 197.47 | 9.22 |
| 9 | Recovery heart rate at 1 min (bts/min) | RcvHR1 | 156.16 | 10.85 |
| 10 | Recovery heart rate at 2 min (bts/min) | RcvHR2 | 135.14 | 10.13 |
| 11 | Recovery heart rate at 3 min (bts/min) | RcvHR3 | 117.70 | 10.42 |

N=242

**Table 2:** Pearson Correlation among Selected Variables of Habitat of High Altitude. Kashmiri Male Youth

| | VO2max | Bwt | Ht. | HRrest | ExHR2 | Ex.HR4 | Ex.HR | RcvHR1 | RcvHR2 | RcvHR3 | AGE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| VO2max | 1 | .090 | .018 | -.700* | -.475* | -.965* | -.092 | -.023 | -.210 | -.380* | -.057 |
| B.wt. | | 1 | .460* | -.116 | -.080 | -.084 | -.122 | -.018 | -.085 | -.123 | -.131 |
| Ht. | | | 1 | -.017 | -.125 | -.040 | -.171 | .056 | -.007 | -.002 | .028 |
| HR rest | | | | 1 | .305* | .692* | -.176 | .004 | .260 | .485* | .021 |
| Ex.HR2 | | | | | 1 | .501* | .290 | .206 | .209 | .234 | -.017 |
| Ex.HR4 | | | | | | 1 | .157 | .013 | .198 | .367* | -.013 |
| Ex.HR6 | | | | | | | 1 | .077 | .017 | -.097 | -.137 |
| RcvHR1 | | | | | | | | 1 | .787* | .586* | -.059 |
| RcvHR2 | | | | | | | | | 1 | .830* | -.077 |
| RcvHR3 | | | | | | | | | | 1 | -.053 |
| AGE | | | | | | | | | | | 1 |

*Significant at 0.05 level

According to table-4, the VO2 max. highly correlated to HRrest (r = -.700), ExHR2 (r = -.475), ExHR4 (r = -.965) and RcvHR3 (r = -.380). The body weight significantly correlates to Ht. (r = .460). Heart Rate Rest (HRrest) significantly correlates to ExHR2 (r = .305), ExHR4 (r = .692) and RcvHR3 (r = .485).ExRH2 highly correlates to ExHR4 (r = .501). ExHR4 significantly correlates to RcvHR3 (r = .367). RcvHR1 highly correlates with RcvHR2 (r = .787) and RcvHR3 (r =.586).RcvHR2 highly correlates with RcvHR3 (r = .830).

**Table 4:** Linear Models Developed for Estimating $VO_2$ Max. of Kashmiri Male Youth (Habitat of High Altitude)

| Model | Linear Model | | | R | R2 | Std.Error of the Estimate | F | Sig. |
|---|---|---|---|---|---|---|---|---|
| | D.V | Constant | Predictor | | | | | |
| 1 | VO2 max | = 58.614 | - .288 (Age) | .057 | .003 | 5.1139 | .786 | .376 |
| 2 | VO2 max | = 49.557 | + .067 (B.wt.) | .090 | .008 | 5.1014 | 1.966 | .162 |
| 3 | VO2 max | =50.622 | + .015 (Height) | .018 | .000 | 5.1214 | .075 | .784 |
| 4 | VO2 max | =75.594 | - .354 (HRrest) | .700 | .490 | 3.6595 | 230.21 | .000 |
| 5 | VO2 max | =91.348 | - .263 (Ex.HR2Min) | .475 | .225 | 4.5080 | 69.855 | .000 |
| 6 | VO2 max | =132.530 | - .454 (Ex.HR4Min.) | .965 | .931 | 1.3411 | 3261.0 | .000 |
| 7 | VO2 max | =67.104 | - .070 (Ex.HR6Min.) | .092 | .008 | 5.1007 | 2.030 | .156 |
| 8 | VO2 max | =54.877 | - .011 (Rcv.HR1Min.) | .023 | .001 | 5.1209 | .124 | .725 |
| 9 | VO2 max | =67.533 | - .106 (Rcv.HR2Min.) | .210 | .044 | 5.0079 | 11.081 | .001 |
| 10 | VO2 max | =75.153 | - .186 (Rcv.HR3Min.) | .380 | .145 | 4.7372 | 40.602 | .000 |

Dependent Variable: $VO_2$max.

The model 1 ($VO_2$max. = 58.614 - .288 × Age) with very poor power of prediction (R2 = .003). The model 2 ($VO_2$max. =

49.557 + .067 × Body weight) with very poor power of prediction (R2 = .008). The model 3 ($VO_2$max. = 50.622 + .015 × Height) with very poor power of prediction (R2 = .000). The model 4 ($VO_2$max. = 75.594 - .354 × HRrest) with very average power of prediction (R2 = .490). The model 5 ($VO_2$max. = 91.348 - .263 × Ex.HR2Min) with poor power of prediction (R2 = .225). The model 6 ($VO_2$max. = 132.530 - .454 × Ex.HR4Min.) with very high power of prediction (R2 = .931). The model 7 ($VO_2$max. = 67.104 - .070 × Ex.HR6Min) with very poor power of prediction (R2 = .008). The model 8 ($VO_2$max. = 54.877 - .011 × RcvHR1Min.) with very poor power of prediction (R2 = .001). The model 9 ($VO_2$max. = 67.533 - .106 × RcvHR2Min.) with very poor power of prediction (R2 = .044) and the model 11 ($VO_2$max. = 75.153 - .186 × RcvHR3Min.) with poor power of prediction (R2 = .145).Hence, model 6 proved to be the best linear model.

A Partial Regression Plot of dependent variable: $VO_2$max. with ExHR4 (heart rate at four minutes of exercise) has been graphically represented in the figure below:

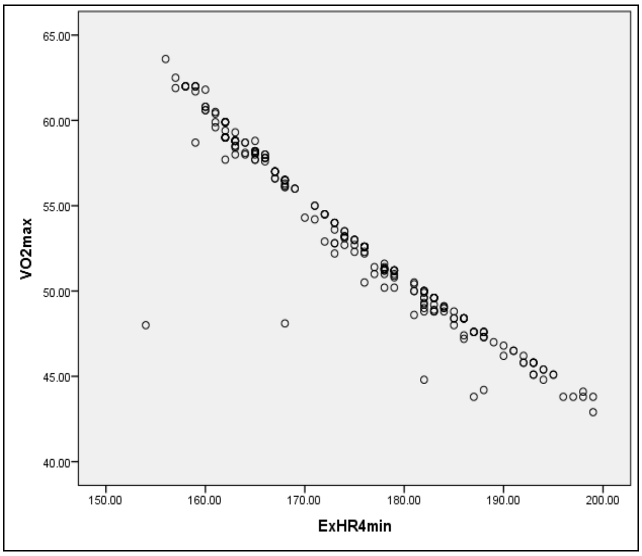


**Fig 1:** Partial Regression Plot with Dependent Variable:$VO_2$max.

**Discussion of Findings**

**Table 5:** Estimation of $VO_2$max. using Developed Linear Models for Kashmiri Male Youth (Habitat of High Altitude)

| Case No | Actual VO2 max. | VO2 max.from Developed Linear Models | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | M1 | M2 | M3 | M4 | M5 | M6 | M7 | M8 | M9 | M10 |
| | | | | | | | | | | | |
| 14 | 60.8 | 53.14 | 52.80 | 53.14 | 56.12 | 53.47 | 59.89 | 52.68 | 53.20 | 52.79 | 54.13 |
| 36 | 59 | 53.14 | 53.77 | 53.23 | 58.24 | 57.68 | 58.98 | 53.66 | 53.27 | 53.22 | 54.69 |
| 95 | 55 | 53.43 | 52.70 | 48.09 | 52.23 | 57.42 | 54.89 | 53.03 | 53.16 | 53.96 | 53.39 |
| 174 | 49.6 | 53.14 | 52.94 | 48.07 | 53.29 | 55.31 | 49.44 | 53.24 | 53.45 | 46.89 | 55.25 |
| 237 | 43.8 | 53.14 | 52.94 | 48.10 | 47.27 | 51.63 | 42.63 | 52.47 | 53.27 | 54.17 | 54.69 |

According to the table-5**,** in regard to the case number14, the actual $VO_2$max. was 60.8.M1 estimated 53.14, M2 estimated 52.80, M3 estimated 53.14, M4 estimated 56.12, M5 estimated 53.47, M6 estimated 59.89, M7 estimated 52.68, M8 estimated VO2 max value of 53.20, M9 estimated 52.79 and M10 estimated VO2max value of 54.13.

Likewise, in regard to the case number36, the actual VO2 max. was 59.M1 estimated 53.14, M2 estimated 53.77, M3 estimated 53.23, M4 estimated 58.24, M5 estimated 57.68, M6 estimated 58.98, M7 estimated 53.66, M8 estimated VO2max value of 53.27, M9 estimated 53.22 and M10 estimated VO2 max value of 54.69.

Likewise, in regard to the case number95, the actual VO2max. was 55.M1 estimated 53.43, M2 estimated 52.70, M3 estimated 48.09, M4 estimated 52.23, M5 estimated 57.42, M6 estimated 54.89, M7 estimated 53.03, M8 estimated $VO_2$max value of 53.16, M9 estimated 53.96 and M10 estimated $VO_2$max value of 53.39.

Likewise, in regard to the case number174, the actual $VO_2$max. was 49.6. M1 estimated 53.14, M2 estimated 52.94, M3 estimated 48.07, M4 estimated 53.29, M5 estimated 55.31, M6 estimated 49.44, M7 estimated 53.24, M8 estimated $VO_2$max value of 53.45, M9 estimated 46.89 and M10 estimated $VO_2$max value of 55.25.

Likewise, in regard to the case number 237, the actual $VO_2$max. was 43.8. M1 estimated 53.14, M2 estimated 52.94, M3 estimated 48.10, M4 estimated 47.27, M5 estimated 51.63, M6 estimated 42.63, M7 estimated 52.47, M8 estimated $VO_2$max value of 53.27, M9 estimated 54.17 and M10 estimated $VO_2$max value of 54.69.

The closest to actual $VO_2$max. value was found in M6 in all the case numbers followed by M4 in regard to case No. 14 and 36, M9 in regard to case N0.95, M3 in case No, 174 and M4 in regard to case No. 237.

Hence model 6 was proved and documented as the best model for estimating the $VO_2$max. value of male youth of Kashmir (habitat of high altitude) with highest power of prediction.

**Conclusions**

- The developed linear models are appropriate for estimating $VO_2$max. for habitat of high altitude Kashmiri youth for aerobic fitness evaluation. Model No. 6 has been documented as most accurate model with highest power of prediction and validity hence is recommended for future research.

**References**

1. Appenzeller O, Minko T, Qualls T *et al* Gene expression, autonomic function and chronic hypoxia: a lesson from the Andes. Clin Auton Res. 2006; 16:217–222.
2. Astrand PO, Cudy TE, Stenberg J. Cardiac output during sub-maximal and maximal work. J.Appl.Physiol.1984; 19: 268-277
3. Center, Room B143, The University of New Mexico, Albuquerque, NM 87131-1258, Phone: (505) 277-2658, FAX: (505) 277-9742.
4. Claydon VE, Gulli G, Slessarev M, Huppert TJ, Assefa T, Gebru S *et al* Blood and plasma volumes in Ethiopian high altitude dwellers. Clin Auton Res. 2005; 15:325.
5. CM Tipton, J Scheuer. Cardiovascular adaptation to physical training, Annu. Rev. Physiol. 1977; 39:221-251.
6. Dlugosz EM, Chappell MA, Meek TH, Szafrańska PA, Zub K, Konarzewski M *et al* Phylogenetic analysis of mammalian maximal oxygen consumption during exercise. Journal of Experimental Biology. 2013; 216(24):4712-4721.

7. Froelicher VF, Myers JN. Exercise and the heart. 4th ed. Philadelphia: W.B. Saunders Compan, 2000.
8. Fox EL. A simple, accurate technique for predicting maximal, aerobic power. J Appl Physiol 1973; 35:914-916
9. Houmard JA, Craib MW, Boien KFO, Smith LL, Israle RG, Wheeler WS. Peak Running Velocity Sub Maximal Energy Expenditure $VO_2$ max and 8 km Distance Running Performance The Journal of Sports Medicine and Physical Fitness. 1991; 31(3):345-350.
10. Robert A, Robergs. Ph.D., FASEP, EPC, Director-Exercise Physiology Laboratories, Exercise Science Program, Department of Physical Performance and Development, 2008.
11. Heyward VH. Advanced fitness assessment and prescription. 3rd ed. Human Kinetics, Champaign Illinois, 1997.
12. Swain DP, Abernathy KS, Smith CS, Lee SJ, Bunn SA. Target heart rates for the development of cardiorespiratory fitness. Med Sci Sports Exerc, 1994; 26(1):112-116.
13. Bates T, Mockler J, Dobrosielski DA. Effects of Altitude on Step Test Performance. In International Journal of Exercise Science: Conference Proceedings, 2015; 9(3):10).
14. VO2 max. norms were adopted from Astrand:ACTA Physiol Scand. 49(Suppl):169,1960
15. Wikipedia, July 2017.
16. ↑http://www.brianmac.co.uk/vo2max.htm
17. ↑https://www.healthstatus.com/health_blog/stroke-2/what-is-a-resting-heart-rate/
18. ↑http://www.mayoclinic.org/healthy-lifestyle/fitness/in-depth/exercise-intensity/art-20046887?pg=2