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VALIDITY OF 2-MILE RUN TEST FOR DETERMINATION OF VO_{2MAX} AMONG SOLDIERS

Sporiš, G[1]

University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia[1]

ABSTRACT

Objectives: The aim of this study was to determine the validity of the 2 miles run test as a predictor of maximum oxygen consumption (VO_{2max}) for soldiers. **Methods**: The study was conducted on a sample of 409 members of Croatian Armed Forces (age 29.10 ± 5.60 years; height 179.44 ± 6.62 cm; body mass 82.39 ± 11.25 kg). The two-mile run was used to assess the aerobic fitness and leg muscles' endurance. **Results**: The results have shown that there was statistically significant correlation between the 2-miles run test and maximal oxygen consumption on absolute level ($r = -0.385$; $p < 0.01$), as well as for the relative values ($r = 0.639$; $p < 0.01$). Significant correlations also exist between the 2-miles run test and body mass ($r = 0.221$, $p < 0.01$). **Conclusion**: The2-miles run test is a fairly accurate and valid method of predicting VO_2max values for male military subjects. This field test is also applicable to a great number of participants, taking into consideration the variability in age and beginning level of physical preparation for many soldiers.

Keywords: military, predicting, maximal oxygen uptake, reliable

INTRODUCTION

Most militaries take a great interest in assessing a soldiers' physical status and level of conditioning, especially aerobic endurance[1-4]. Consequently, training methods aimed at developing aerobic endurance is part of almost all military training. However, assessing aerobic endurance may be difficult to implement due to the large number of participants

Throughout the last several decades, numerous sport-motoric tests have been used by the military to assess a soldiers´ physical readiness and fitness[5-8]. To be widely used, the test must be applicable for large heterogeneous groups [7-11]. The determination of aerobic capacity in the laboratory is time consuming and requires technical personnel and sophisticated instrumentation. Hence, attempts have been made to specify a field test that has a good correlation with VO_2max[12-14]. Malhotra et al. have recomended the long distance cycling time trial as a predictor of VO_{2max}[15]. This test is based on field performanceand can be measured by distance covered in a specified time or by time taken to cover a specific distance. A common test for determination of aerobic endurance and VO_{2max} of soldiers is the 2 miles run test. It represents one of the three parts of The Army Physical Fitness Test (APFT),that is used by the **North Atlantic Treaty Organization** (NATO) members for determination of muscular endurance and cardio-respiratory fitness[16]. The duration of this test is 25 minutes[17] and can be performed with a large number of participants depending on the track and terrain configuration.

Therefore, the aim of this study was to determine the validity of the 2 miles run test as apredictor for the assessment of maximum oxygen consumption (VO_2max) of soldiers.

METHODS

Participants

For the purpose of this study 409 Members of Croatian Armed Forces (age 29.10 ± 5.60 years; height 179.44 ± 6.62 cm; body mass 82.39 ± 11.25 kg) were tested. This research was approved by the Ethics Committee of the Faculty of Kinesiology, University of Zagreb. All subjects were submitted to health examination before the testing and only individuals with adequate health status, and doctor permission, were allowed to participate in the study. This research is part of the project "Investigation of human resources and potential" implemented by the Ministry of Defence of the Republic of Croatia and in collaboration with the Faculty of Kinesiology, University of Zagreb.

Procedures

Laboratory assessments were undertaken at the Faculty of Kinesiology, University of Zagreb, Croatia. Each soldier was measured by experienced anthropometrics prior to the measurement of VO_2max. Body mass was assessed to the nearest 0.1 kg using a Beam balance scale with the athletes wearing minimal clothing. Body height was assessed to the nearest 0.1 cm using portable Stadiometer. The Stadiometer and scale were calibrated periodically during the study to ensure accuracy.

Two-Mile Run: First, all soldiers will line up behind the starting line. On the command, a clock will start and soldiers will begin running at their own pace around a standard 400 meter track. The primary objective ais to cover the 2-mile course in the shortest time possible. Although walking is authorized, it is strongly discouraged. If a soldier is physically assisted in any way (for example, pulled, pushed, picked up, and/or carried) or leave the designated running course for any reason, they will be disqualified It is acceptrable to for an instructor to pace a soldier during the 2-mile run provided there is no physical contact with the and it does not hinder other soldiers Cheering or calling out the elapsed time is also permitted.

Experimental protocols

To prevent unnecessary fatigue accumulation, subjects were asked to refrain from strenuous exercise for 24 h prior to the exercise test. After a self-selected warm-up and stretching, based upon the subject's habits, VO_2max was measured by a standard incremental maximal exercise test protocol performed on a motor-driven treadmill (Run race, Technogym, Italy) with a 1.5% inclination. During the testing period the air temperature ranged from 21°C to 23°C The testing was performed in morning hours (between 9 am and 13 am) in thermo-neutral conditions. After 1 minute of measuring VO_2 at rest (standing position), the starting speed was 3 km/h, with speed increments of 0.5 km/h every 30 seconds. The subjects walked the first few steps (up to 6 km/h), and continued running from 7 km/h, until volitional exhaustion. Expired gas was sampled continuously and O_2 and CO_2 concentration in expired gas were determined using stable and fast Zirconium Oxygen and NDIR Carbon Dioxide analyzers (breath-by-breath gas exchange system Quark b^2, COSMED, Italy) which were calibrated prior to and following each test using precision reference gases. The system was calibrated before each test using gases of known concentrations. Heart rate (HR) was collected continuously during the tests using a telemetric heart rate monitor (Polar Electro, Kempele, Finland), and stored in PC memory. Expired airflow was measured with a digital turbine flow meter (COSMED, Italy), which was calibrated prior to and following each test using a syringe at flow rate and volumes in the expected physiological range. Temperature and humidity of expired gas were measured using a rapidly-responding sensor (Quark b^2, COSMED, Italy). End-of-test criteria for the determination of maximal oxygen uptake (VO_2max) included two of the following: 1) volitional exhaustion, 2) achieving a plateau in VO_2 (highest values were calculated as arithmetic means of the two consecutive highest 30s values), and 3) HR ≥ 90% of age-predicted maximum. All subjects refrained from exercise for 24 h before testing. During recovery after test protocol, the subjects walked at 5 km/h for 2 minutes. The last half or full stage the subject could sustain (for either 30 s) was defined as the subject's maximal speed.

Statistical analysis

The collected data were store and analyzed for windows statistical software (Statistica for Windows 7.0). Descriptive statistics were calculated for all experimental data. Kolmogorov-Smirnov test was used to test if data were normally distributed. Linear regression and Pearson product movement coefficient of correlation was used to determinate relationship between 2-miles run and VO_2max among military personal. Statistical significance was set at $p < 0.05$.

RESULTS

The Kolmogorov-Smirnov test has shown that the data were normally distributed. The difference in terms of the age of participants was extremely big, with range from 19.10 to 47.60 age. According to this fact, other variables have also shown the big difference between minimal and maximal values. This can be especially seen in the variable 2-miles run, where the minimal value was 11.21 minutes and maximal 27.23 minutes (Table I). In addition, the oxygen consumption which has been tested by direct method, has the lowest value of RVO_{2max} = 35.72 mL O_2/kg/min and the greatest RVO_{2max} = 71.14 mL O_2/kg/min. The average values for the heartbeat were similar for both, the 2-miles run test ($HR_{max\ 2\text{-miles run}}$ = 192.32 ± 9.66 bpm) and for the direct measurement of oxygen consumption (HR_{max}=191.89 ± 8.87 bpm).

Table II shows that there is statistically significant correlation between the 2-miles run test and maximal oxygen consumption on absolute level (r = -0.385; $p < 0.01$), as well as for the relative values (r = 0.639; $p < 0.01$). Besides this, the 2-miles run test shows correlation with body mass ($p < 0.01$), as well as with the age of participants (r = 0.230) (Table II). There was no significant correlation between body height and the 2-miles run test ($r = 0.061$; $p = 0.21$).

TABLE I. Basic Descriptive Parameters

	Mean ± SD	Minimum - Maximum
Age (Years)	29.10±5.59	19.10 - 47.60
HR rest (bpm)	73.22±10.04	46.00 - 100.00
Body height (cm)	179.44±6.62	160.50 - 201.60
Body mass (kg)	82.39±11.24	69.50 - 120.60
2-mile run (min)	16.36±2.50	11.21 - 27.23
2-mile run (s)	993.84±150.52	681.00 - 1643.00
$RVO_{2\ max}$ (mL O_2/kg/min)	50.29±7.05	35.72 - 71.14
$VO_{2\ max}$ (L O_2/min)	4.13±0.60	2.57 - 5.86
Speed max (km/h)	14.57±1.85	11.00 - 20.00
HR_{max} (bpm)	191.89±8.87	163.00 - 214.00
$HR_{max\ KF}$ (bpm)	192.03±2.07	185.18 - 195.73
$HR_{max\ 2\text{-}mile\ run}$ (bpm)	192.32±9.66	163.00 - 221.00

HR rest- heart rate at rest; VO_{2max} - maximal oxygen uptake; RVO_{2max} – relative oxygen uptake; Speed max - maximal running speed; HR_{max} - maximal heart rate achieved in the test

TABLE II. Correlation Between 2-mile Run and VO_{2max}

	Age	Body height	Body mass	$RVO_{2\ max}$	$VO2_{max}$	Speed max
2-mile run (s)	.2306	.0615	.2219	-.6394	-.3851	-.7931
p	0.000	0.214	0.000	0.000	0.000	0.000

VO_{2max} - maximal oxygen uptake; RVO_{2max} – relative oxygen uptake; Speed max - maximal running speed;

DISCUSSION

A soldier's level of aerobic fitness plays a vital role in deciding their ability to carry out duties required during emergency and combat conditions. A simple and accurate test to determine aerobic fitness of soldiers is necessary based on the large number of individuals that must be tested, as well as time and equipment constraints. One of the most important indicators of physiological fitness, cardiovascular health, and total work output is one's maximal oxygen uptake[18,19].

VO_2max values have quite large variations among the general population, mostly arising from natural endowment factors ,as well as levels of physical activity. The average VO_2max per unit of body weight has been found to be remarkably constant in different groups once they are matched in physical activity habits. Many studies have been conducted to assess the VO_2max values in military personnel. The minimum requirement of aerobic capacity (VO_2max) for a US Air Force male between the ages 25 and 29 years and between 30 and 34 years to meet the Air Force fitness standards is 34 and 32 mL O_2/kg/min respectively[20]. Shvartz and Reibold[21] have stated that these results fall under the poor aerobic fitness category.

Ghosh et al.[13] have found negative linear correlations between distance running performance and VO2max. Distance running performance was determined either from time taken to cover a certain distance or from distance covered within a certain time. In most of these studies, subjects were required to run for more than 5-6 min at their maximum speed, which was determined by the ability to maintain a high steady state level of oxygen consumption. Although most researches have reported a higher VO_2max values on treadmill ttests when compared to a bicycle ergometer (3.6 to 6.0% higher),the bicycle ergometer is still frequently used[18]. Ghosh et al.[13] have reported a high correlation ($r = -0.82$) between VO_2max measured using bicycle ergometer and 2.4 km run time[13] . The results of the present study also indicate that the time taken to complete the 2-miles run test exhibited a negative correlation ($r = -0.38$) with VO_2max. However, the correlation was not as high as obtained with 2.4 km run.

Therefore, it can be concluded that the 2-miles run test protocol is a fairly accurate and valid method to predict VO_2max values in male military subjects. This field test is also applicable to great number of participants, taking into consideration the variability in age, gender and beginning level of physical preparedness for each soldier. This is important based on the heterogeneous nature of the participants in our study. Based on this, it appears this test can be used for the selection in evaluation of aerobic endurance. During this study, more then 400 soldiers were tested. Special emphasis was put on the practicality and sensibility in scoring procedure and implementation in military cause. However, further studies are needed in order to confirm the validity of tests for power, agility and coordination, based on a comprehensive test battery to determine motoric abilities for each soldier. A good selection of tests will enable more quality candidates which would lead to a better combat preparation of whole units. Formulating a battery of motoric tests ,as well as specific criteria for physical fitness evaluations is a challenging, yet extremely important task. Therefore these methods should be constantly verified in practice, and investigated and confirmed by scientific work methods. Periodical verification of an existing test battery applied in practice can thus serve as one of the forms of its evaluation.

Using tests other armies employ, or have already been tested, sometimes appears to be the easiest and best way to select an assessment. However, geographical, socio-demographic and other characteristics must be also taken into consideration, as well as the differences between various cultures. In order to establish or verify the state of affairs, future studies must be conducted. By doing this, new questions will arise that will enable further critical understanding. In this way research becomes a sensible continuum.

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