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Original Research

Software for Calculating Cardiorespiratory Fitness and Prescribing the Endurance Exercise Training

Marefat Siahkouhian*[1] , Nader Alijanpour[2], Roghayyeh Gholizadeh[3]

1-3 Department of Sport Physiology, Faculty of Education Sciences and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran.

ABSTRACT

Low cardiorespiratory fitness increases the risk of chronic disease and mortality. However; cardiorespiratory fitness testing is not usually performed at many health care facilities. cardiorespiratory fitness tests are an essential way to assess a person's related -health physical fitness. However, achieving these tests is difficult and time-consuming and requires a sports physiologist. The purpose of this study is software design to predict cardiorespiratory fitness with individual information from health indicators that express the results of cardiorespiratory fitness tests. The statistical population of the study will be all physically healthy people. The research sample is people from this statistical population who have participated in cardiorespiratory fitness tests. We created a computer software program that, after receiving information from the test subject (age, sex, height, weight, heart rate), determined the results of the cardiorespiratory fitness tests and the fitness status of the subjects based on international and national norms. The software also provides training programs based on the level of cardiorespiratory fitness of the test subject. For convenience, test results files and exercise program files can be printed. The results showed that in samples under 25 years of age, the level of cardiorespiratory fitness was moderate to low; Between 35 and 45 and over 35, the average is high. Based on the results obtained, it can be concluded that the software designed to estimate functional cardiorespiratory fitness is functional. The low CRF among the samples under 25 years old is shown compared with the study samples and international norms. However; the presentation of exercise programs and physical activity by the physical fitness of these people is inevitable.

Keywords: Cardiorespiratory fitness, Fitness tests, Software design, Endurance exercise training

Corresponding Author: Marefat Siahkouhian**,** Department of Sport Physiology, Faculty of Education Sciences and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran, Email: M_siahkohian@uma.ac.ir, Tel(optional):(+98)9144511435.

INTRODUCTION

With the rapid development of the economy, automatic machines have replaced many workers, and as a result, sedentary living has become commonplace in human societies. According; to the World Health Organization, a sedentary lifestyle is the fourth most crucial risk factor globally; a sedentary lifestyle is the leading cause of more than two million deaths. About 60-85% of adults in the world are inactive, and two-thirds of children are passive, which threatens their health and causes health problems (1, 2). From; a health perspective, people have functional cardiopulmonary fitness, can continue to exercise longer, get tired later, and are more resistant to heart and respiratory disease. Increasing, cardiorespiratory endurance is an essential issue for maintaining improved health (3, 4).

High cardiorespiratory fitness (CRF) improves health-related quality of life (HRQOL) in the community, especially in the elderly (5, 6). A; regular public health study has highlighted the relationship between physical activity and HRQOL in all adults (6, 7). In particular, they noted a positive association between physical activity and HRQOL.

Cardiorespiratory fitness (CRF) refers to the capacity of the circulatory and respiratory systems to supply oxygen to skeletal muscle mitochondria for energy production needed during physical activity. CRF is an important marker of physical and mental health and academic achievement in youth. CRF can be directly measured as maximal oxygen consumption ($\dot{V}O_2max$) or often estimate as metabolic equivalents (MET) from cardiopulmonary exercise testing. CRF is not only a sensitive and reliable measure of physical activity (8), but also a relatively inexpensive and functional health indicator for patients (9-11). According; to the World Health Organization (WHO), high blood pressure, smoking, diabetes, sedentary lifestyle, and obesity account for 38% of all global mortality. (12). The American Heart Association (AHA) stated that ideal cardiovascular disease (CVD) health defines the perfect cardiovascular health as the simultaneous presence of four perfect health behaviors (non-smoking, body mass index (BMI) <25 kg/m2, physical activity at goal levels, and pursuit of a recommended diet) and three health factors (untreated total cholesterol <200 mg/dL, untreated blood pressure <120/80 mmHg, and fasting blood glucose <100 mg/dL) (13). Scientific evidence suggests that such behaviors and factors reported by WHO and AHA are directly or indirectly related to CRF (8, 14-16). However; CRF tests are complicated and very time-consuming for older. On the other hand, the interpretation of test results requires a sports physiologist to be able to provide training programs appropriate to the CRF in addition to interpreting the test results. Currently, a small number of screening methods enable the pure determination of cardiorespiratory fitness. These methods need a unique environment and special conditions (17).

Recent research has developed comprehensive and practical software for estimating people's CRF to facilitate the achievement of CRF test results and the quick ability to interpret the results of these tests. This software uses the information entered by the person, such as height, weight, heart rate, etc. According to the test that the person has chosen to estimate the CRF, determines the CRF status of the person about national and international norms. Finally, according to the status of the CRF being tested and to improve a person's cardiovascular function, the software provides a training program. For convenience, trail results and exercise program files can be printed.

MATERIAL AND METHODS

Design of CRF software is in the form of an educational multimedia CD using internal and external resources and computer programming by using Excel and Visual Basic software, as well as HTML program, JavaScript , which will provide the possibility of subjects to test software; Such as the Balk, Bruce test, the YMCA bike test, the Harvard, Quinn, Rockport and Cooper tests, and 1.5 miles (2.41 km) running test. The statistical population of the study will be all physically healthy people. The research sample is people from this statistical population who have participated in CRF tests.

The data required in this study were collected using the designed software. In this regard, CRF software was designed using Javascript and HTML programming software on various Internet sites. The data collected from the results of previous research, which in the form of CRF norms constitute different age groups of Iranian society, were compared with the standards available in other countries.

Inferential statistical methods (analysis of variance and LSD tracking test) were used to analyze the data and compare CRF internal norms with international standards.

RESULTS

How to work with designed software

In the designed software, the related data to each CRP test can be entered to perform the necessary calculations. The following shows how to use the Rockport test in the software with the relevant details.

After running the CRF software, the main category of the software will be displayed.

Fig 1: Main page of the software

Select Rockport test From the list of CRF tests. After opening the Rockport test page, fill in the specified fields with the information related to the test subject.

Fig 2: Rockport test page

The Rockport Walking Test is used to determine cardiovascular fitness. The purpose of this test is to measure VO2 max (maximum amount of oxygen used during strenuous exercise, expressed in milliliters per kilogram per minute) (18). After calculating VO2 max, CRF software compares the status of the tested CRF with national and international norms and according to the quality of the CRF being tested, it provides a training program.

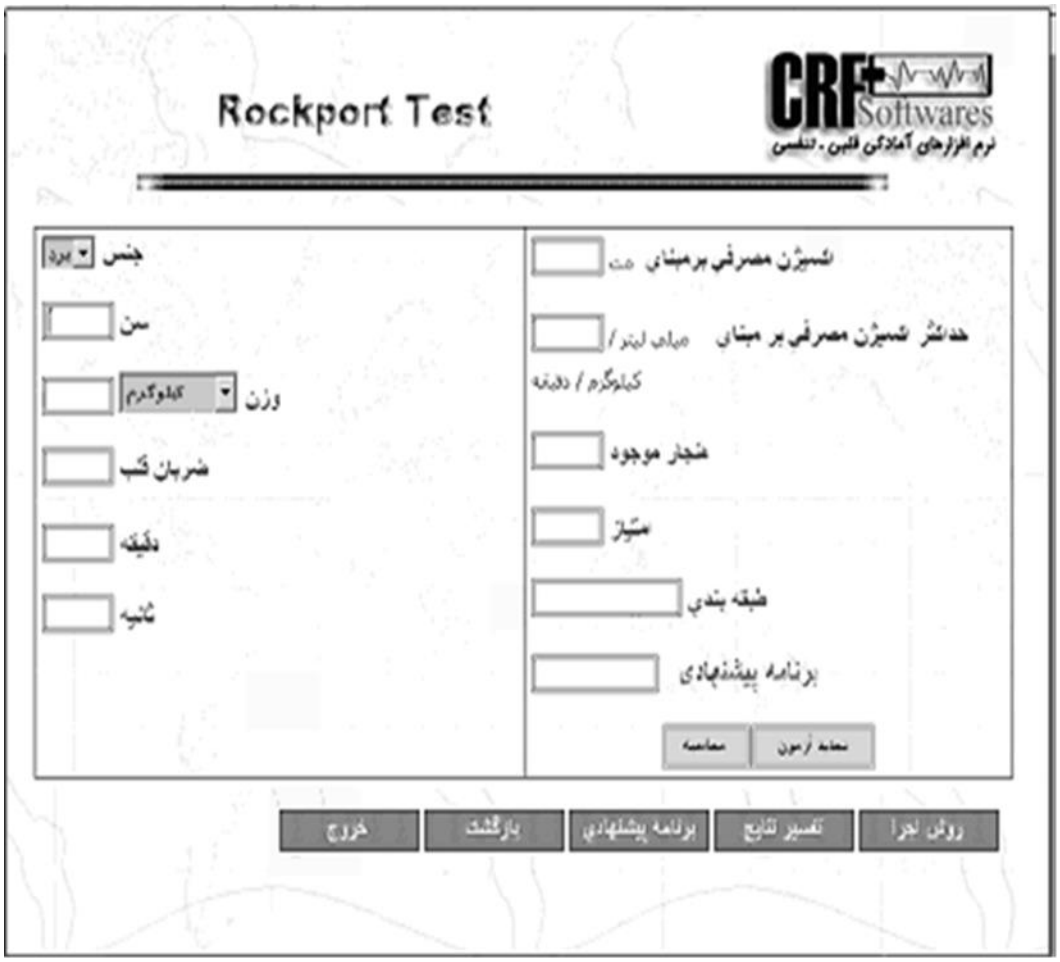

Fig 3: Rockport test results and suggested exercise program

The results of this test will help your doctor or personal trainer design an appropriate exercise program based on your fitness. The results can also be used to assess your progress after exercising. CRF software is a valuable tool for anyone who wants to design workouts tailored to their cardiovascular fitness, especially those with physical limitations and the ability to perform field and laboratory tests to measure CRF. CRF software helps you determine your VO2 max. It also allows you to improve the situation.

Comparison of the condition of cardiac-respiratory readiness of Iranian samples with international norms

The results of the present study showed that in the samples under 25 years old, the level of cardio-respiratory fitness in comparison with international standards is moderate to low, i.e., 39 mL/kg/min (Fig2).

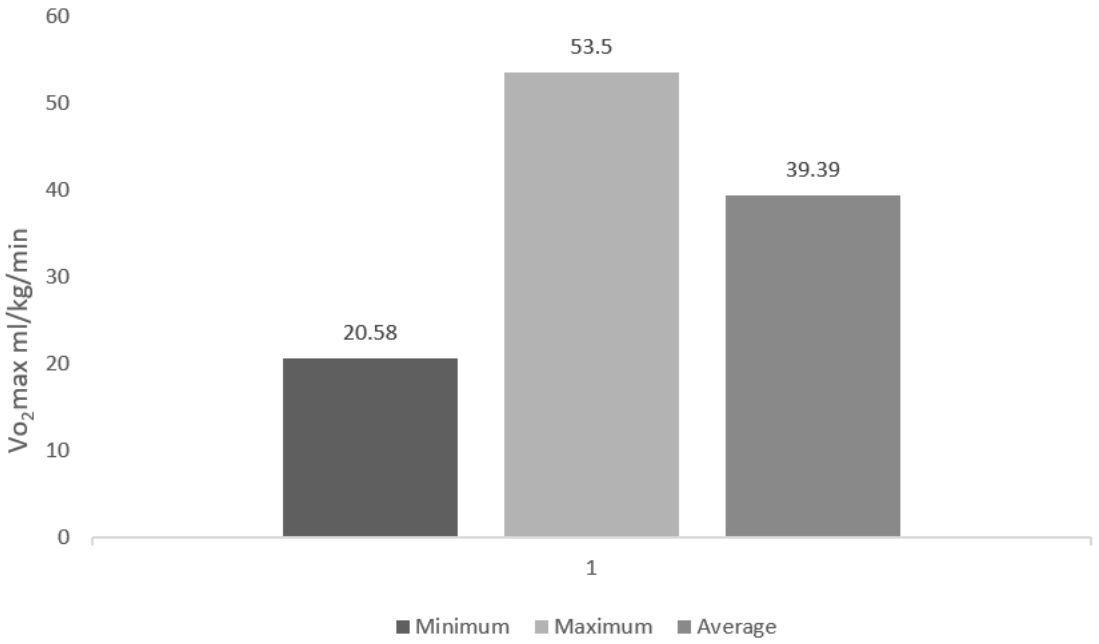

Fig 4 : Average, minimum, and maximum VO_2max in samples under 25 years old.

The results also showed that in samples between 25 to 35 years old, the level of cardio-respiratory fitness compared to international standards was moderate to high, i.e., 47.58 mL/kg/min (Fig3).

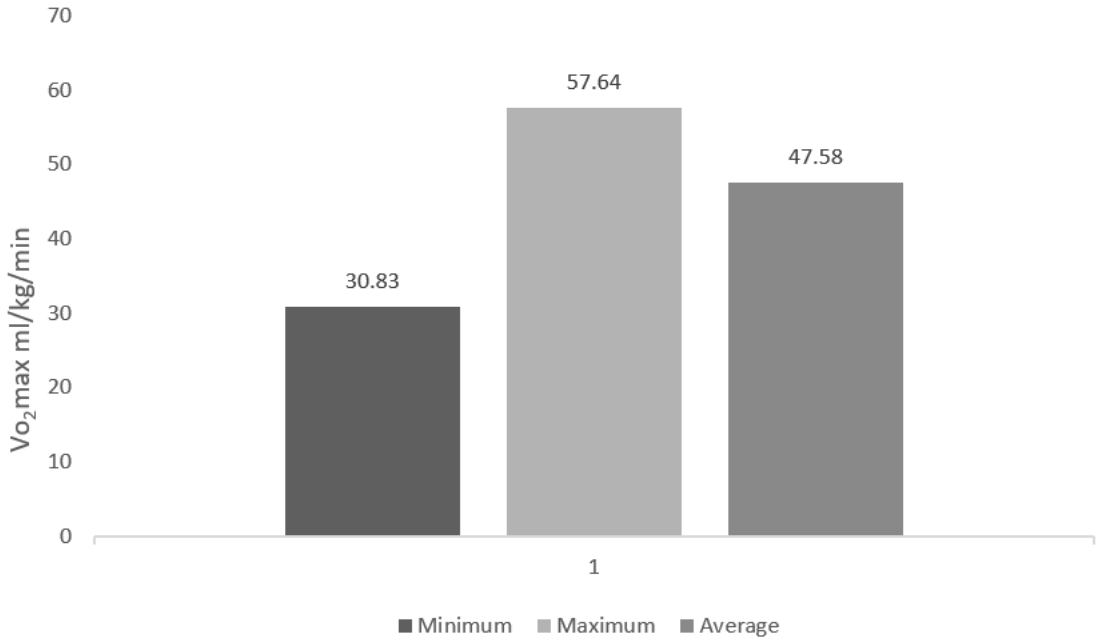

Fig 5: Average, minimum, and maximum VO_2max in samples between 25 to 35 years old

The findings also showed that in samples over 35 years old, the level of cardiorespiratory fitness compared to international standards was moderate to high, i.e., 40.83 mL/kg/min (chart 3).

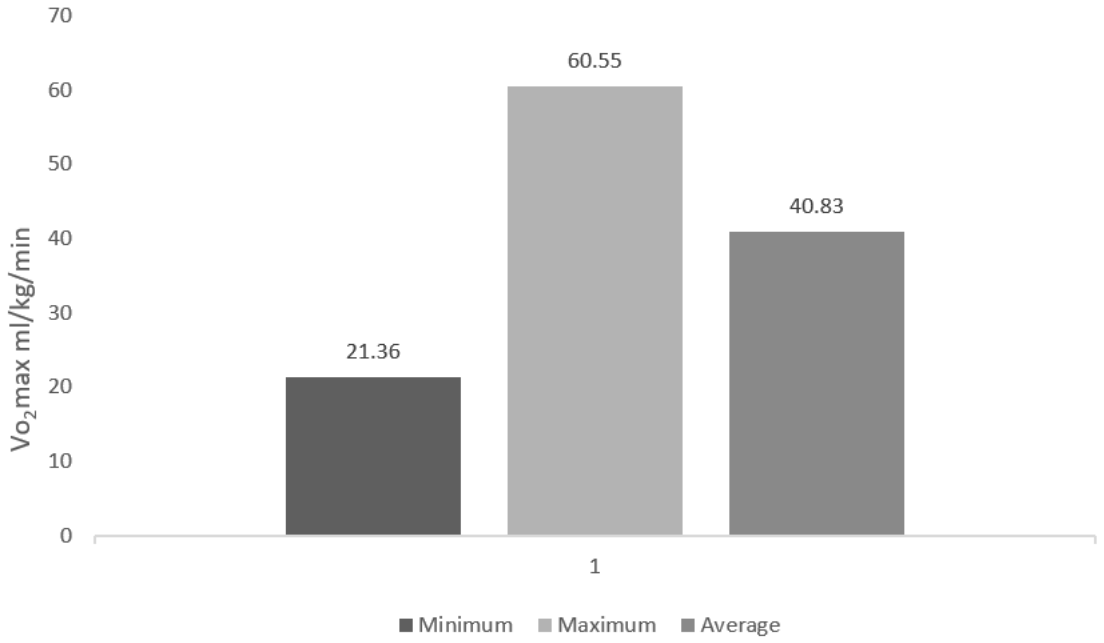

Fig 6: Average, minimum, and maximum VO_2max in samples over 35 years old

DISCUSSION

CRF is a strong predictor of mortality in sedentary individuals and individuals with metabolic or cardiovascular disease(19-21). Despite the association between mortality risk and CRF, it is impossible to assess CRF in many healthcare settings(19, 22). This study aimed to design suitable software for CRF prediction without exercise testing.

If CRF is evaluated in health centers, there should be a meaningful way to interpret the results, determine the risk and identify patients. CRF measurement will be functional provided a precise level of differentiation between high-risk individuals and healthy individuals (23). At present, there is no complete consensus on the level of CRF in which individuals are at risk of cardiorespiratory disease and those who adequate cardiorespiratory fitness can be distinguished. However; studies have shown that 9 to 10 MET for men and 7 to 8 MET for women is an appropriate MET level associated with a 50% reduction in mortality risk(21, 24). Determining the amount of CRF functional for diagnosing people at risk of mortality cannot be based on a relative measurement(23), However observations may reveal a fitness level that can be subjected to more rigorous and clinically relevant sensitivity and specificity assessment such as receiver-operating characteristic analysis(24, 25).

There are three reasons for establishing a criterion level of CRF. First; low CRF carries the same or higher strength of association and attributable risk for mortality as routinely measured clinical risk factors (19, 20, 22). Second; the high level of CRF can has a favorable impact on metabolic risk indicator such as; blood pressure, triglycerides, glycemic control, and body fat distribution (25), identifying and intervening on low CRF may have other health benefits beyond the attributable fraction of mortality risk that has been reported for low fitness. Third, there is a growing urgency for additional clinical measures to improve traditional

approaches of identifying the high-risk asymptomatic patient who would benefit from intensive primary preventive therapy(24).

The results of the present study showed that the software designed without the need for special tools and equipment and referred to sports science specialists could assess the CRF status of individuals accurately. The CRF software also offers a unique training program based on physical ability, BMI, gender, age, and level of readiness. This software makes self-assessment possible. Also, the software offers not only fast, and accurate evaluation, but also provides complete information to the user, which eliminates the user's in-person visit, and receives advice from coaches and sports scientists.

CONCLUSION

The low CRF among the samples under 25 years old is shown compared with the study samples and international norms. Lack of regular aerobic physical activity and improper cardiopulmonary fitness with overweight can lead to cardiovascular diseases, high blood pressure and diabetes. However; the presentation of exercise programs and physical activity by the physical fitness of these people is inevitable.

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چکیده فارسی

نرم افزاری برای محاسبه تناسب قلب و تنفس و تجویز تمرینات استقامتی

معرفت سیاه کوهیان[1]، نادر علیجان پور[2]، رقیه قلیزاده[3]

۱-۳گروه فیزیولوژی ورزشی، دانشکده علوم تربیتی و روان شناسی، دانشگاه محقق اردبیلی، اردبیل، ایران.

آمادگی قلبی-تنفسی خطر بیماری های مزمن و مرگ و میر را افزایش می دهد. با این حال ، بررسی آمادگی قلبی تنفسی معمولاً در بسیاری از مراکز بهداشتی درمانی انجام نمی‌شود. تست‌های آمادگی قلبی-تنفسی یک روش اساسی برای ارزیابی آمادگی جسمانی فرد در ارتباط با سلامتی است. اما انجام این آزمایش‌ها دشوار و وقت گیر است و نیاز به یک فیزیولوژیست ورزشی دارد. هدف از این مطالعه طراحی نرم افزاری برای پیش بینی آمادگی قلبی تنفسی از شاخص‌های سلامتی است که نتایج آزمایشات آمادگی قلبی تنفسی را بدون نیاز به آزمایش و با اطلاعات فردی بیان می کند. جامعه آماری تحقیق همه افراد از نظر جسمی سالم خواهند بود. نمونه تحقیق افرادی از این جامعه آماری هستند که در آزمونهای آمادگی اندام قلبی تنفسی شرکت کرده اند. ما یک برنامه نرم افزاری رایانه ای ایجاد کردیم که پس از دریافت اطلاعات از آزمودنی (سن ، جنس ، قد، وزن، ضربان قلب)، نتایج آزمونهای تناسب اندام قلبی تنفسی و وضعیت تناسب اندام افراد را بر اساس هنجارهای بین المللی و ملی تعیین کرد. این نرم افزار همچنین برنامه‌های آموزشی مبتنی بر سطح آمادگی قلبی تنفسی آزمودنی را ارائه می دهد. برای راحتی کار ، پرونده های نتایج آزمون و پرونده های برنامه ورزشی قابل چاپ هستند. نتایج نشان داد که در نمونه های زیر ۲۵ سال، سطح آمادگی قلبی تنفسی متوسط تا پایین بود. بین ۳۵ تا ٤٥ و بالاتر از ۳۵ ،از میانگین زیادتر است. بر اساس نتایج به دست آمده، می‌توان نتیجه گرفت که نرم افزاری که برای تخمین آمادگی تنفسی تنفسی مفید طراحی شده مفید است. با توجه به اینکه سطح آمادگی قلبی تنفسی نمونه‌های زیر ۲۵ سال در ایران در مقایسه با هنجارهای بین المللی پایین است، ارائه برنامه‌های آموزشی متناسب با شرایط تناسب اندام ادر ین افراد ضروری است.

واژه‌های کلیدی: آمادگی قلب و تنفس، تست‌های آمادگی، طراحی نرم افزار، تمرین ورزش استقامتی