Journal of Exercise and Health Science, Vol. 1, No. 1, Winter 2021, page 23-36

Original Article

Designing an Advanced Physical Fitness Assessment Software for Various Social Classes in Iran

Seyed Kazem Mousavi Sadati[1], Hamid. Rajabi[2]

1. Assistant professor of motor behavior, Department of Physical Education & Sport Sciences, East Tehran branch, Islamic Azad University, Tehran, Iran. (Corresponding Author)
2. Professor of Exercise Physiology, Kharazmi University, Tehran, Iran.

Received: 2020/09/14 **Accepted: 2021/01/31**

Abstract

The aim of this study was to design and implement an advanced physical fitness assessment (APFA) software for the Iranian society. This applied study was conducted to improve, complement and facilitate the measurement and evaluation methods of motor and health physical fitness criteria. The software was designed using various tests, formulas, national and international norms, percentage rank as well as T and Z scores. A correlational analysis of the data from 100 individuals was done using APFA, and the results were obtained from Excel and manual methods with an intraclass correlation (ICC=1, P<0.001). Moreover, the Spearman's correlation (r=1, P<0.001) coefficient showed that the software met the reliability and validity criteria. The APFA is capable of fast and easy measurement, assessment, calculation and analysis of various physical fitness indicators related to body health, movement and type in various classes of the Iranian society grouped by age, gender and sports. Further, it can also be used to accurately determine the qualitative rank (weak, average and so on) and quantitative score of athletes and nonathletes in a battery of physical fitness tests. The APFA is recommended to personal users, authorities of gymnasiums, schools and universities as well as those interested in accurately measuring, assessing, calculating and analyzing various physical fitness criteria and abilities.

Keywords: Software, Assessment, Physical Fitness, Motor Fitness

1. Email: drmousavisadati@gmail.com
2. Email: hrajabi1346@gmail.com

Introduction

Today, physical education coaches, teachers and professors or generally those involved in sport preparation improve the physical fitness and athletic performance of individuals under their supervision by assessing their skills as well as physical and motor fitness from a medical and health standpoint on a schedule. In many advanced countries, the gymnasiums and bodybuilding, health, and rehabilitation centers take numerous tests from individuals before beginning any exercises for health purposes (1). Cross-sectional and longitudinal studies in Europe reveal that physical fitness is an important indicator of youth and child health and can be used to predict health in the upcoming stages of an individual's life (2, 3). These findings sustain the need for physical fitness tests in healthcare systems. Moreover, the World Health Organization (WHO) is in favor of regular physical fitness and activity examinations as a priority for improving public health (4).

Assessment is the principal part of the decision-making process and encompasses all educational behaviors. Physical fitness assessment, evaluation and measurement are a measure and indicator of a good schedule as well as its objectives since teachers and coaches can measure individuals' motor and physical abilities, evaluate the results to discover their weaknesses and strengths and plan the next schedules accordingly. The goal of physical fitness assessment is to adapt the training and exercise schedule to the learners' characteristics based on the principle of individual differences (5, 6). Methods of measuring and assessing various aspects of physical fitness are the basis of exercise planning and scientific studies which represent information to researchers, teachers and coaches in order to evaluate the individual's current conditions and predict their future progress (7).

The evaluation and assessment processes help determine whether an athlete has the necessary and acceptable performance. For example, measuring the oxygen consumption of athletes poses the first question about their condition. The oxygen consumption is a raw number and certainly does not represent enough information, requiring the evaluation of what is obtained and measured. In other words, there should be a criterion or norm to evaluate the individual's current condition. In any case, the assessment accuracy is dependent on the quality of the collected information (valid, objective and reliable tests) as well as the relevant norm formulation methods (8).

Nowadays, computers are necessary to obtain, collect, analyze and interpret the parameters measured in sports, obtaining and processing data, ubiquitous computing, databases, computer video systems (tracking and movement analysis), modeling (in accordance with information technology, biomechanics, physiology and mathematics), simulation (animation and interactive), game analysis, multimedia (e.g. virtual reality), theory development as well as electronic

education and learning (9). Computers and computer software are a part of physical education and sports environments. Computer applications in motor and physical fitness assessment allow sport teachers, coaches and professors to make education and coaching more appealing, to be effective teachers and to improve learners' athletic performance (10-13). In this regard, new software is designed and built every day according to the needs. Kashef (2008) designed the norm software which can produce norms from participants' records and use their total percentage rank from various tests to rank people from strong to weak. Installing this software requires Visual Basic (14). Mosuavi Sadati (2009) has designed the software of physical fitness assessment, which can determine individuals' quantitative and qualitative scores in a set of physical fitness tests, delineate 13 body types, obtain the maximum oxygen consumption and endurance using the 2400 meter Cooper tests, running with the 12-minute Cooper test, Rockport 1609 walk and 15-minute Balke test as well as qualitatively evaluate the subjects' cardiovascular endurance (7). Danesh Salar-e Iranian designed the National Olympic Academy's physical fitness assessment and evaluation software to evaluate the physical fitness criteria and monitor the athletes through a season considering age, gender and sport (15). Mahmoudkhani et al. designed the anthropometry software with unique features including the use of Iranian teenagers' (3 to 22-year-old age group) anthropometric norms to calculate and describe the physical dimension deviation of teen subjects as Z scores and compare them to the normal distribution of the Iranian teen population (16). In addition, many software applications have been designed overseas, which are often inaccessible in Iran or face many usage limitations in the few cases where they are available (17, 18). Despite the importance of designing a software for evaluating the various physical fitness criteria and abilities, the studies illustrate that a comprehensive software has not been designed in Iran, yet by credible physical education and scientific institutes or is inaccessible to physical education experts and those interested in it. The lack of specialized software to assess and evaluate different aspects of learners' and athletes' physical fitness is perceptible; therefore, designing a comprehensive and advanced physical fitness assessment software to facilitate qualitative and quantitative analysis of physical fitness tests is a necessity. Designing a software that is able to objectify behavioral goals can help individuals and their children to achieve a better and deeper understanding of their physical fitness as well as can prove useful by specifying educational and behavioral goals and creating incentive in addition to motivation in order to reach the intended behavioral objectives. Moreover, such a software will reduce the time taken for quantitative and qualitative interpretation of raw scores from physical exams (health and motor physical fitness, body composition, type and so on), determine physical education scores and delineate the participants' individual and group rankings in fitness competitions.

Methodology

This applied-developmental study was conducted to correct and complement methods of physical fitness criteria and ability assessment and evaluation and to design and produce an advanced physical fitness assessment software. Although a specific population cannot be attributed to the study due to its nature, the data from a hypothetical 100-participant sample aged 18-90 years were used to evaluate the software's efficiency not only in its performance and capabilities with various populations and classes, but also in determining its reliability. From this point of view, the present study is a descriptive correlational study.

The following instruments were applied in the current study: 1. Microsoft Office Word for preliminary form design, 2. the C# engineering software for designing software forms and programming, 3. the Structured Query Language or SQL for designing databases, 4. ASP.NET MVC for designing the web-based version.

This software was executed through the following stages: A) Library research, collecting information and norms from credible foreign and domestic sources and selecting the tests, B) Categorizing tests and preparing a list of menus and submenus, C) Designing the software's input and output forms and the method of obtaining results, D) Software design and programming, investigating the software's validity and reliability, E) Final evaluation of software by experts and project supervisors, F) Resolving potential deficiencies, G) Preparing the testing and software manual, and I) Producing educational multimedia content.

For there are countless physical fitness tests and library research, gathering information about physical fitness tests and selecting tests with suitable validity and reliability are extremely important. In this stage, the tests (test validity and reliability as well as software's ability to perform calculations) were selected from credible sources and websites (19-26) in accordance with research objectives and were organized under the software's menus and submenus.

Results

The aim of the current study was to design an advanced physical fitness assessment (APFA) software (figure 1) which could assess and evaluate the participants' abilities in different motor and health fitness tests including body composition, maximum oxygen consumption, cardiovascular endurance, muscular endurance, muscular strength, flexibility, speed, balance, strength and agility.

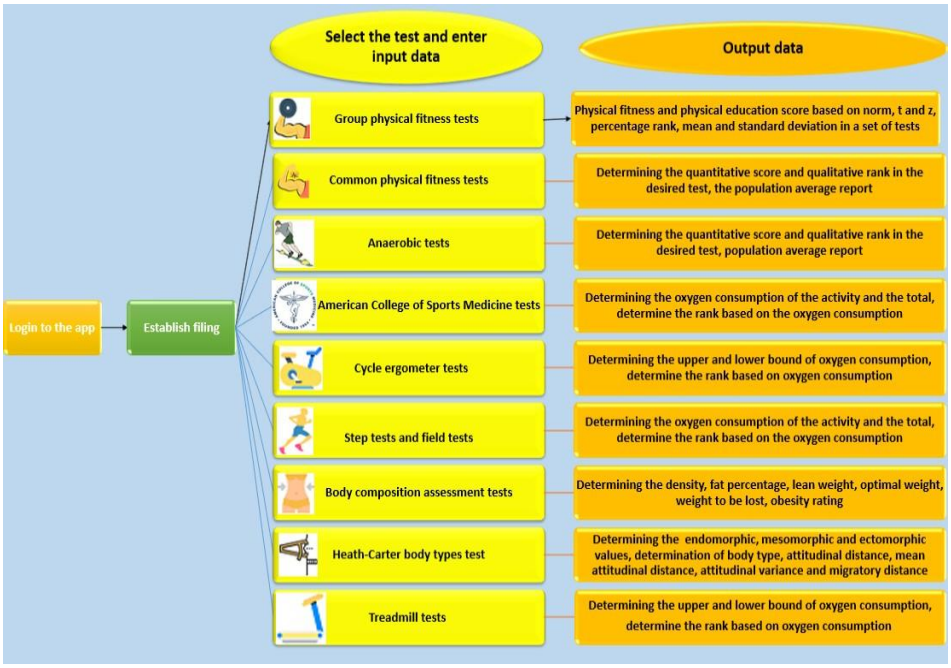


Figure 1- Information graph of advanced physical fitness assessment (APFA) software

The Reliability of APFA

The body composition, maximum oxygen consumption, body mass index, cardiovascular endurance, body type and other characteristics of 100 individuals were manually calculated with APFA and Microsoft Excel in order to check the reliability of APFA's calculations and test its performance. The Kolmogorov–Smirnov test demonstrated a normal data distribution ($P>0.05$), and since the obtained results were in the interval and ratio scales, the intraclass correlation coefficient (ICC) and Spearman's correlation coefficient were used for assessing reliability. The ICC is a reliability index that reflects both degree of correlation and agreement between measurements. It has been widely used to evaluate interrater, test-retest and intrarater reliability of numerical or continuous measurements (27, 28). The results illustrated that the correlation coefficient was direct and complete ($ICC=1$, $r=1$, $P<0.001$), and the APFA was reliable. Therefore, users and those interested in it can be assured of using the software for physical fitness assessment. For error-free computer calculations always lead to a single result, the APFA's computational method also meets the test-retest reliability.

Software Features and Calculations

APFA's most important functions and calculations are as follows.

1. Laboratory estimation of participants' total maximum oxygen consumption and qualitative assessment of cardiovascular endurance through walking, arm and leg ergometry, running and stepping tests according to the American College of Sports Medicine protocols (22, 29), the treadmill tests using the active and inactive men's Balke test, active and inactive women's Balke test, active and inactive men's Bruce test, active and inactive women's Bruce test, Bruce test of heart disease patients and the elderly, Naughton test of men with heart-disease, Ebbeling's test of 20-59 years, George et al.'s formulas for 18-28 years old (30-32), ergometer tests using the Fox's maximum test, Åstrand-Ryhming's submaximum test, and Åstrand's maximum test (32, 33).
2. Field estimation of participants' maximum oxygen consumption and qualitative analysis of cardiovascular endurance using the George et al.'s (1993) one-mile jog, Cureton et al.'s (1995) one-mile run or walk (8 to 17-years), George et al.'s (1993) 1.5-mile run or walk, Larsen et al.'s (2002) 1.5-mile run or walk, Cooper's (1968) 13-minute test, Balke's (1963) 15-minute test, Kline et al.'s (1987) one-mile walk, the Rockport Fitness Walking Test (34-38), Cureton's one-mile run or walk test (8-17 years), Mahar et al. and Leger et al. 's 20-meter shuttle run tests, the 6-minute walk test and 2-minute stair test for the elderly (39, 40) and the step tests using the Harvard step, Nagel step, Naughton step, Åstrand step, Queens College step, and the Forestry step tests (41).
3. Determining the 18-year or older participants' average and total skinfold thickness, body density, body fat, optimal weight and qualitative evaluation of both genders' body composition using three, four and seven points: Chest, armpit, triceps, scapula, abdomen, suprailiac site and thigh in male and female participants younger than 18 using two-point skinfold: Triceps and leg calf, and triceps and subscapularis (42-44).
4. Delineating three criteria of body type, body type group (13 groups), average body type, attitudinal distance, average attitudinal distance and body type attitudinal variance, longitudinal time-series analysis of body type (migratory distance) of participants using the Heath-Carter test (45).
5. Determining qualitative ranks (weak, average, good, very good, excellent) and quantitative evaluation of participants' Health Screening (Body Mass Index, and the Waist to Hip Ratio, Target Heart Rate), Flexibility and Mobility (Sit and Reach Flexibility), Muscular Strength and Endurance (Push-up, Bench Press, Sit-up, Senior's Stand from chair, Senior's Curl, Curl-up / Half Sit-up, One Rep Max), Power (Vertical Jump, Sprint Speed), Body Composition (Kid

and Adult), anaerobic (Wingate, Rast), Aerobic Testing (Walkport, 12-Minute Running, Bruce and Balke treadmill tests, 1.5 and 2 miles running)

6. Delineating the ranking and scores for each test in a set of physical tests according to default provincial and national norms in software (these norms were put in software by default or entered by user), and the raw scores recorded for participants.
7. Converting units of temperature, weight, pressure, length, volume, energy and power.
8. The software and norm update function, the ability to swap default norms with new norms of the same format and increasing the software's usability for different age groups considered by users.
9. The ability to obtain 20-value norms from subjects' records.
10. The ability to arrange output information in ascending and descending order simultaneously based on three criteria.
11. The ability to print output information (reported results) with the user's desired header and logo.
12. The ability to export and save results in PDF, CSV, TEST, HTML, XLS, MHT, RTF, XLSX and IMAGE formats.
13. Providing images and explanations about the objective and execution of every test, estimating parameters and criteria via secondary calculation or nomograms of certain tests.
14. Providing a user manual and multimedia educational content for testing with the software.
15. The ability to create backups of default, input and output information as well as software updates.

Sample Report Produced by the Software

The one sample report produced using the APFA software is presented in figure 2.

Discussion

Developing technology as well as designing and building sport softwares are one of the most important applied science priorities in sports. Having understood this priority, the research center of the Physical Education Organization has taken important steps in this regard, and performing the ongoing study is an important step for designing APFA application. This software can evaluate and assess the participants' abilities in various physical fitness tests associated with health and movement including body composition, maximum oxygen consumption, cardiovascular endurance, muscle strength, strength, speed, muscle endurance, flexibility, balance and agility. Despite its very diverse and extraordinary features and capabilities, the APFA has some limitations that users should consider; and if

the researchers are inclined to work in this field, they are welcome to present designs to mitigate these deficiencies. Not all norms could be saved by default in software because of the huge variety of foreign and domestic norms as well as budgetary and time constraints; hence, the researchers may need to import their desired norms into the software or update its default norms. Although this software offers precise assessment, calculation, measurement and analysis of criteria as well as various physical fitness capabilities, these calculations (e.g. body volume, fat and type) are done using formulas with certain percentages of error, which the users should keep in mind about the software's calculations. Because many of the norms related to provinces are unavailable, the researchers who would like to obtain the results of various tests (including physical fitness tests in school or university classes or various physical fitness competitions) using various provincial or researcher-made norms must import the norms to the software beforehand. However, this software will facilitate the acquisition of athletes' performance in various competitions using the percentage ranking and T score without any default norms. Creating graphs with APFA requires exporting data to Excel and using it for drawing graphs.

Conclusion

Many unique abilities and features of the APFA software have led to precise, easy and fast measurement, assessment, calculation as well as analysis of various physical fitness abilities and criteria. Moreover, for the APFA has the necessary validity and reliability, it is recommended for users and those interested in it to measure, assess, calculate and analyze various physical fitness abilities and criteria easily and quickly.

Acknowledgments

This research project was conducted based on the financial support and supervision of the Sport Sciences Research Institute of the Ministry of Science, Research and Technology, and the collaboration of the East Tehran Branch of the Islamic Azad University. Hereby, the authors would like to thank the honorable officials of the Physical Education and Sports Sciences Research Institute and the East Tehran Branch of the Islamic Azad University.

Authors' contributions

All authors contributed in running, designing and writing all parts of the article.

گزارش آزمون فردی

وزارت علوم، تحقیقات و فناوری-پژوهشگاه تربیت بدنی و علوم ورزشی

شرکت کننده: ناصر رشیدی **سن:** ۱۹

آزمون شرکت شده	۱۲ دقیقه دویدن	
	واحد مسافت	مایل
	مسافت	۱.۸

امتیاز: ۸۸. میانگین جامعه: ۴۶.۵۴. اکسیژن مصرفی: ۵۳.۴۶. مت: ۱۵.۲۷. رتبه/ تفسیر: عالی

آزمون شرکت شده	انعطاف پذیری نشستن و رساندن دست	
	مقدار کشش	۴۵

امتیاز: ۴۸. میانگین جامعه: ۴۵.۵۹. رتبه/ تفسیر: متوسط

آزمون شرکت شده	ایستادن از صندلی بزرگسالان	
	تعداد	۵۰

میانگین جامعه: ۲۲. امتیاز: ۱۰۱. رتبه/ تفسیر: عالی.

آزمون شرکت شده	پرس سینه	
	تعداد	۵۰

میانگین جامعه: ۲۷. امتیاز: ۹۶. رتبه/ تفسیر: عالی.

آزمون شرکت شده	پرش عمودی	
	وزن	۱۰۵
	ارتفاع تور	۵۰
	جمعیت	۱۶

میانگین جامعه: ۴۶.۲۲۸. امتیاز: ۷۳. رتبه/ تفسیر: خوب. توان میانگین: ۶۳۰

آزمون شرکت شده	ترکیب بدن بزرگسالان	
	وزن	۱۰۹
	Nosites	۳
	سینه ای	۱۴
	خط میانی زیر بغل	
	تحت کتفی	
	شکم	۱۷
	فوق خاصره ای	
	چهارسر ران	۱۸
	سه سر بازویی	

چگالی: ۱.۰۶۷۸۲۲۷. وزن بدون چربی: ۹۴.۲۱۹۴۸۸۵۴۴۳۰۶. وزن چربی: ۱۴.۷۸. درصد چربی: ۱۳.۵۶. میانگین جامعه: ۱۶.۲۸۵. امتیاز: ۶۷. رتبه/ تفسیر: متوسط

آزمون شرکت شده	ترکیب بدن کودکان	
	وزن	۵۴
	سه سر بازویی	۶
	ساق پا	۱۰
وزن بدون چربی: ۴۷.۱۱ وزن چربی: ۶.۸۹ درصد چربی: ۱۲.۷۶ یازده بهینه: ۱۰ – ۱۹.۹ رتبه/ تفسیر: رنج بهینه		

آزمون شرکت شده	جلوبازو با دمبل	
	تعداد	۴۰
میانگین جامعه: ۳۵ امتیاز: ۹۹ رتبه/ تفسیر: عالی.		

آزمون شرکت شده	دراز و نشست	
	تعداد	۶۰
میانگین جامعه: ۴۵ امتیاز: ۹۸ رتبه/ تفسیر: عالی.		

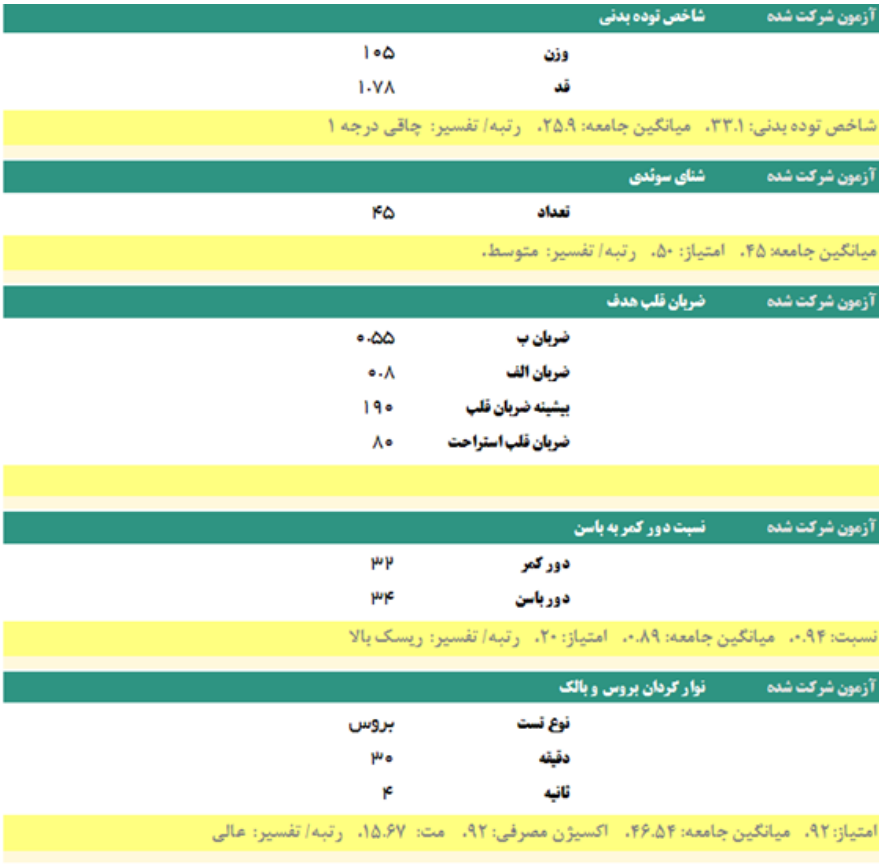
آزمون شرکت شده	دراز و نشست نیمه	
	پروتکل	ACSM
	تعداد	۶۰
میانگین جامعه: ۲۸ امتیاز: ۷۸ رتبه/ تفسیر: خوب.		

آزمون شرکت شده	دوچرخه کارسنج یاماکا	
	وزن	۸۰
	واحد کار (یاماکا)	وات
	کار مرحله اول	۱۸۰
	کار مرحله دوم	۲۰۰
	ضربان مرحله اول	۱۴۰
	ضربان مرحله دوم	۱۴۵
امتیاز: ۱۰۱ میانگین جامعه: ۴۶.۵۴ اکسیژن مصرفی: ۷۲.۵۱ مت: ۲۰.۷۲ رتبه/ تفسیر: عالی		

آزمون شرکت شده	دوی استقامت	
	دقیقه	۱۰
	ثانیه	۲
	نوع یک و نیم	۱.۵
امتیاز: ۸۰ میانگین جامعه: ۴۶.۵۴ اکسیژن مصرفی: ۵۱.۶۴ مت: ۱۴.۷۵ رتبه/ تفسیر: خوب		

آزمون شرکت شده	دوی سرعت	
	جمعیت اسپرینت	مردان ۱۶ سال ۴۰ متر
	ثانیه	۶
امتیاز: ۶۰ میانگین جامعه: ۶.۲۴ رتبه/ تفسیر: متوسط		

آزمون شرکت شده	راه رفتن راکپورت	
	دقیقه	۱۲
	ثانیه	۳
	ضربان قلب	۱۵۰
	وزن	۱۰۸
امتیاز: ۷۶ میانگین جامعه: ۴۶.۵۴ اکسیژن مصرفی: ۵۰.۷۱ مت: ۱۴.۴۹ رتبه/ تفسیر: خوب		



آزمون شرکت شده	شاخص توده بدنی	
	وزن	۱۰۵
	قد	۱.۷۸

شاخص توده بدنی: ۳۳.۱. میانگین جامعه: ۲۵.۹. رتبه/ تفسیر: چاقی درجه ۱

آزمون شرکت شده	شنای سوئدی	
	تعداد	۴۵

میانگین جامعه: ۴۵. امتیاز: ۵۰. رتبه/ تفسیر: متوسط.

آزمون شرکت شده	ضربان قلب هدف	
	ضربان ب	۰.۵۵
	ضربان الف	۰.۸
	بیشینه ضربان قلب	۱۹۰
	ضربان قلب استراحت	۸۰

آزمون شرکت شده	نسبت دور کمر به باسن	
	دور کمر	۳۲
	دور باسن	۳۴

نسبت: ۰.۹۴. میانگین جامعه: ۰.۸۹. امتیاز: ۲۰. رتبه/ تفسیر: ریسک بالا

آزمون شرکت شده	نوار کردان بروس و بالک	
	نوع تست	بروس
	دقیقه	۳۰
	ثانیه	۴

امتیاز: ۹۲. میانگین جامعه: ۴۶.۵۴. اکسیژن مصرفی: ۹۲. مت: ۱۵.۶۷. رتبه/ تفسیر: عالی

Figure 2- Sample report produced by software

References

1. Gharakhanlou R, kordi R, Gaeini A, Vaez Mousavi K, Kashef M. Physical fitness, Skill and, Psycholological Evaluation Tests For Elite Athletes. National Olympic Committee of the Islamic Republic of Iran; 2006. p. 25-6 (in persian).
2. Kolimechkov S. Physical Fitness Assessment in Children and Adolescents: A Systematic Review. European Journal of Physical Education and Sport Science. 2017.
3. Ruiz JR, Castro-Piñero J, España-Romero V, Artero EG, Ortega FB, Cuenca MM, et al. Field-based fitness assessment in young people: the ALPHA health-related fitness test battery for children and adolescents. British journal of sports medicine. 2011;45(6):518-24.
4. Organization WH. Global tuberculosis control: WHO report 2010: World Health Organization; 2010.
5. Tolgfors B. Different versions of assessment for learning in the subject of physical education. Physical Education and Sport Pedagogy. 2018;23(3):311-27.
6. Tolgfors B, Öhman M. The implications of assessment for learning in physical education and health. European Physical Education Review. 2016;22(2):150-66.
7. Mousavi Sadati SK. Designing of Physical fitness evaluation software. Research in Sport Sciences. 2010;29(6):13-30 (in persian).
8. Sheikh M, Shabazi M, Tahmasebi S. Measurement and Evaluation in Physical Education and sport sciences. BAMDADKETAB; 2007. p. 12-30 (in persian).
9. Novatchkov H, Baca A. Computer Science in Sport. Encyclopedia of Information Science and Technology, Third Edition: IGI Global; 2015. p. 6885-91.
10. Baca A. Computer science in sport: an overview of history, present fields and future applications (part I). International Journal of Computer Science in Sport. 2006;4(1):25-35.
11. Kaur D. Application of computer in physical education and sports. 2017.
12. Kaur I. Computer use in Physical Education and Sports Teaching. Asian Journal of Research in Social Sciences and Humanities. 2015;5(4):134-41.
13. Link D, Lames M. Sport Informatics: Historical Roots, Interdisciplinarity and Future Developments. International Journal of Computer Science in Sport. 2009;8(2):68-87.
14. KASHEF M. INTRODUCING STANDARD NORM PROVIDING SOFTWARE (HANJAR). RESEARCH ON SPORT SCIENCE. 2008;6(18):-
15. Danesh salar i. National Olympic Academy Physical Fitness Assessment and Evaluation Software 1394 [Available from: https://dsikala.com/products/%d9%86%d8%b1%d9%85-%d8%a7%d9%81%d8%b2%d8%a7%d8%b1-%d8%a2%da%a9%d8%a7%d8%af%d9%85%db%8c-%d9%85%d9%84%db%8c-%d8%a7%d9%84%d9%85%d9%be%db%8c%da%a9/.
16. Mahmoudkhani MR, Barati AH. Design and construction of software anthropometric. Research in Sport Medicine and Technology. 1391;1391(12):42-27.
17. Ortner M. 1999; [Available from: https://www.capterra.com/fitness-software/.
18. Duffy J. [Available from: https://www.pcmag.com/article/334976/the-best-fitness-apps-for-2019.
19. Hemmati nazhad MA, rahmani nia F, Hemmati nazhad M, Tayebi SM. Measurement and Evaluation in Physical Education and spss. Hatmi; 2007. p. 50-4 (in persian).

20. Heyward VH. (Advanced fitness assessment and exercise prescription 6th edition). Azad A, Hamedinia Mohamad R, Rajabi H, Gaeini abbas A, (persian translator). Samt; 2014. (in persian) p.
21. Heyward VH, Gibson A. Advanced fitness assessment and exercise prescription 7th edition: Human kinetics; 2014.
22. Medicine ACoS. ACSM's health-related physical fitness assessment manual: Lippincott Williams & Wilkins; 2013.
23. Medicine ACoS. ACSM's guidelines for exercise testing and prescription: Lippincott Williams & Wilkins; 2013.
24. Medicine ACoS. (ACSM's guidelines for exercise testing and prescription). Gaeini Abbas A, Samadi A, Khalesi M, (persian teranslator). Hatmi; 2013.
25. Miller T, Association C. NSCA's Guide to Tests and Assessments: Human Kinetics; 2012.
26. Miller T, Association C. (NSCA's Guide to Tests and Assessments). Gaeini Abbas S, Panahi S, Khaledi N, Sedgh rohi G, Milani F,Vakili J,(persian translator): Hatmi; 2012. (in persian) p.
27. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. Journal of chiropractic medicine. 2016;15(2):155-63.
28. Carroll KM, Wagle JP, Sato K, DeWeese BH, Mizuguchi S, Stone MH. Reliability of a commercially available and algorithm-based kinetic analysis software compared to manual-based software. Sports biomechanics. 2019;18(1):1-9.
29. Gibson AL, Wagner D, Heyward V. Advanced Fitness Assessment and Exercise Prescription, 8E: Human kinetics; 2018.
30. Foster C, Jackson AS, Pollock ML, Taylor MM, Hare J, Sennett SM, et al. Generalized equations for predicting functional capacity from treadmill performance. American heart journal. 1984;107(6):1229-34.
31. Ebbeling CB, Ward A, Puleo EM, Widrick J, Rippe JM. Development of a single-stage submaximal treadmill walking test. Medicine and science in sports and exercise. 1991;23(8):966-73.
32. McConnell TR, Clark BA. Prediction of maximal oxygen consumption during handrail-supported treadmill exercise. Journal of Cardiopulmonary Rehabilitation and Prevention. 1987;7(7):324-31.
33. Fox EL. A simple, accurate technique for predicting maximal aerobic power. Journal of Applied Physiology. 1973;35(6):914-6.
34. Fenstermaker KL, Plowman SA, Looney MA. Validation of the Rockport Fitness Walking Test in females 65 years and older. Research quarterly for exercise and sport. 1992;63(3):322-7.
35. Kline C, Porcari JP, Hintermeister R, Freedson PS, Ward A, Mccarron RF, et al. Estimation of from a one-mile track walk, gender, age and body weight. Med Sports Exerc. 1987;19:253-9.
36. Balke B. A simple field test for the assessment of physical fitness. Civil Aerospace Medical Institute, 1963.
37. Cooper KH. A means of assessing maximal oxygen intake: correlation between field and treadmill testing. Jama. 1968;203(3):201-4.

38. Larsen GE, George JD, Alexander JL, Fellingham GW, Aldana SG, Parcell AC. Prediction of maximum oxygen consumption from walking, jogging, or running. Research Quarterly for Exercise and Sport. 2002;73(1):66-72.
39. Mahar MT, Guerieri AM, Hanna MS, Kemble CD. Estimation of aerobic fitness from 20-m multistage shuttle run test performance. American journal of preventive medicine. 2011;41(4):S117-S23.
40. Leger LA, Mercier D, Gadoury C, Lambert J. The multistage 20 metre shuttle run test for aerobic fitness. Journal of sports sciences. 1988;6(2):93-101.
41. McARDLE W, Katch F, Pechar G, Jacobson L, Ruck S. Reliability and interrelationships between maximal oxygen intake, physical work capacity and step-test scores in college women. Medicine and science in sports. 1972;4(4):182-6.
42. Peterson MJ, Czerwinski SA, Siervogel RM. Development and validation of skinfold-thickness prediction equations with a 4-compartment model. The American journal of clinical nutrition. 2003;77(5):1186-91.
43. Jackson AS, Pollock ML. Generalized equations for predicting body density of men. British journal of nutrition. 1978;40(3):497-504.
44. Jackson AS, Pollock ML, Ward A. Generalized equations for predicting body density of women. Medicine and science in sports and exercise. 1980;12(3):175-81.
45. Easton R, Reilly T. kin anthropometry and exercise Physiology Laboratory manual. New York: E & FN spon 1996. p. 50-35.