Original Article

Investigating the Relationship between Maximum Aerobic Capacity and Cognitive Ability and Employees' Workability in a Dairy Factory

Mohammad Faridan[1], Neda Mahdavi[2,3], Leila Tajik[4], Rasool Mohammadi[5], Faezeh Alizadeh[6], Faezeh Abdikia[6]

[1]Research Center of Environmental Health, Department of Occupational Health Engineering and Safety at Work School of Health and Nutrition, Lorestan University of Medical Sciences, Khoraamabad, Iran, [2]Department of Ergonomics, Occupational Health and Safety Research Center, School of Public Health, Hamadan University of Medical Sciences, Hamadan, Iran, [3]Center of Excellence for Occupational Health, Occupational Health and Safety Research Center, School of Public Health, Hamadan University of Medical Sciences, Hamadan, Iran, [4]Nutritional Health Research Center, Department of Occupational Health Engineering and Safety at Work School of Health and Nutrition, Lorestan University of Medical Sciences, Khoraamabad, Iran, [5]Nutritional Health Research Center, Department of Biostatistics and Epidemiology School of Health and Nutrition, Lorestan University of Medical Sciences, Khoraamabad, Iran, [6]Department of Occupational Health Engineering and Safety at Work, School of Health and Nutrition, Lorestan University of Medical Sciences, Khorramabad, Iran

Abstract

Aim: Considering the importance and necessity of physical and mental fitness of the employees with their job demands, this study aimed to estimate the levels of aerobic capacity among the workers and determine the factors that might affect these levels. The relationship between the aerobic capacity levels and the values of workers' cognitive function and workability was also investigated. **Materials and Methods:** Sixty healthy male employees from a dairy factory were recruited using a random sampling method. The study design consisted of the completion of checklists containing personal data, anthropometric measurements, and evaluation of job ability, maximum aerobic capacity along with the cognitive ability of the participants using the Workability Index (WAI) standard questionnaire, Queen's College step test, and psychomotor vigilance test (PVT), respectively. **Results:** The mean values of $VO_{2\ max}$, reaction time (RT), and WAI of workers were 45.54 ± 6.13 mL/kg/min, 337.82 ± 29.93 ms, and 42.76 ± 5.02, respectively. Based on the Pearson correlation test, a weak statically significant correlation was observed between PVT and $VO_{2\ max}$ ($r = 0.3$, $P = 0.02$) as well as PVT and physical work capacity ($r = 0.263$, $P = 0.04$). The findings of this study showed that there was a significant relationship between height, weight, body mass index, RT, and error percentage with maximal aerobic capacity ($VO_{2\ max}$). **Conclusion:** According to the physiological criteria, the employees' capabilities and job requirements are not in balance; particularly for those working in laboratory, office, or service departments. Therefore, using standardized recruitment tests, providing sports facilities and developing integrated indicators are a principal element of establishing an ergonomic balance in this workplace.

Keywords: Cognitive ability, physical work capacity, physiological fit, $VO_{2\ max}$, workability index

Introduction

Assessing employees' physical ability is vital for employers economically and as a strategy for increasing productivity. However, when employees' abilities do not match job requirements, it leads to various problems such as health and safety issues, decreased income and well-being, lower product quality, and morale, and increased turnover and lost work time.[1,2] In summary, assigning employees to suitable jobs based on their abilities helps determine their energy levels and physiological characteristics for optimal performance.[3]

Maximum aerobic capacity ($VO_{2\ max}$) is used to estimate the match between work demands and a worker's physiological capacity. It is considered the gold standard for measuring cardiorespiratory fitness (CRF), representing the highest amount of oxygen consumption during maximal exercise.[4] $VO_{2\ max}$ is influenced by various factors, including physical,

Access this article online

Quick Response Code:

Website: www.ijehe.org

DOI: 10.4103/ijehe.ijehe_46_22

Address for correspondence: Dr. Leila Tajik,
Nutritional Health Research Center, Department of Occupational Health Engineering and Safety at Work School of Health and Nutrition, Lorestan University of Medical Sciences, Khoraamabad, Iran.
E-mail: l.tajik@lums.ac.ir

How to cite this article: Faridan M, Mahdavi N, Tajik L, Mohammadi R, Alizadeh F, Abdikia F. Investigating the relationship between maximum aerobic capacity and cognitive ability and employees' workability in a dairy factory. Int J Env Health Eng 2024;13:15.

Received: 16-09-2022, **Revised:** 09-09-2023, **Accepted:** 22-11-2023, **Published:** 31-07-2024

mental, environmental, and physiological parameters.[5] It also decreases with age, with the highest values typically observed in the 18–25 years of age group and lower values in women than men.[3] Regular exercise training can significantly increase $VO_{2\ max}$.[3] It serves as a reliable criterion for assessing CRF, depending on the function of organs and systems involved in oxygen delivery. Any disorder or disease affecting these organs and systems can lead to a decrease in maximum aerobic capacity.[6]

$VO_{2\ max}$ can be estimated using maximal or submaximal tests, either directly or indirectly. Direct measurement is more reliable but expensive, requiring specialized equipment and laboratory conditions. Indirect methods use formulas derived from conventional tests and offer simpler and cheaper alternatives with reasonable validity.[7,8] Ergometer bicycles, treadmills, and steps are commonly used tools for measuring $VO_{2\ max}$.[9] Step tests are brief, easy to administer, require minimal equipment and space, and can be used for all ages. Different step protocols and equations are used to calculate $VO_{2\ max}$.[6]

Cognitive ability is how well someone can think, process information, make decisions, and remember things.[10] It affects how well someone can perform tasks and helps prevent errors. Studies have shown that regular aerobic exercise can improve cognitive function, including memory and resilience to stress.[11] Physical fitness is also connected to cognitive functions like short-term memory.[12]

Workability refers to a worker's ability to perform their job, which is influenced by various factors such as physical and mental abilities, working conditions, and health status.[13,14] Monitoring workability is important, and the workability index (WAI) questionnaire is a reliable tool developed by the Finnish Institute of Occupational Health.[15] It assesses workability from the employee's perspective and can predict potential health issues. Several studies have shown the WAI to be valid in predicting long-term sickness absence and disability.[16] However, it is influenced by factors such as age, lifestyle, physical capacity, and job demands.[17]

Most research in this field has focused on the relationship between aerobic capacity and cognitive and functional abilities in athletes,[11,18,19] students,[10,20] and the physical and mental fitness of employees in the workplace is often overlooked. Employees in the work environment face ergonomic risks such as long working hours, stressful conditions, and poor posture. These risks can lead to musculoskeletal disorders, absenteeism, and job dissatisfaction. It is crucial to maintain a balance between physiological and psychological well-being to effectively perform work tasks and manage these risk factors.

This study examines the importance of physical and mental fitness for workers and the impact on job performance and safety. It aims to estimate aerobic capacity, determine influential factors, and explore the relationship between cognitive function and workability in a dairy factory. The study also examines the physiological fitness of these workers. The findings can be used as a guide for preemployment exams and selecting physically and physiologically fit individuals for the job. It also suggests an approach to improve cognitive ability and reduce occupational accidents and human errors.

Materials and Methods

Study population

Sixty healthy male subjects from a dairy factory were randomly selected for the study. The sample size was calculated based on the study of Firoozeh *et al*.,[21] with a maximum aerobic capacity deviation of $\sigma = 3.28$, significance level of 95% ($\alpha = 0.05$), and accuracy of $d = 1$. The average age, height, and weight of the participants were 37.17 ± 6.34 years, 174.2 ± 7.3 cm, and 77.56 ± 11.3 kg, respectively. All selected subjects had no history of debilitating diseases, musculoskeletal disorders, or orthopedic limitations that would prevent intense exercise testing. They were included in the study after meeting the inclusion/exclusion criteria (inclusion criteria: at least 1 year of work experience, age <50 years and exclusion criteria: high blood pressure, history of cardiopulmonary diseases, diabetes, skeletal muscular disorders, and orthopedic limitations) and providing informed consent. All participant data were analyzed and reported anonymously.

Study design

Each participant completed several steps during the assessment. The first step involved signing the informed consent form and completing a checklist with personal data such as gender, age, work experience, marital status, level of education, smoking habits, and work shift. Referring to the fact that anthropometric variables such as weight and height have a significant relationship with maximum aerobic capacity of the individuals.[22] A brief preliminary anthropometric study of the subjects was performed to measure the values of their height, weight, and body mass index (BMI). Medical scales were used to assess these measurements. Finally, the participants' job ability, maximum aerobic capacity, and cognitive ability, including reaction time (RT), were evaluated using the WAI standard questionnaire, Queen's College step test, and psychomotor vigilance test (PVT), respectively.

The fact that the production process at the factory had to be halted to execute the step and the cognition test on the subjects was considered a limitation of this study. This limitation is almost typical of the research that has been conducted in the field of occupational health and safety.

Workability index questionnaire

The WAI questionnaire is a commonly used self-assessment tool for determining a person's work capacity. It assesses an employee's ability to perform their job duties considering their overall health and wellness, job requirements, and available resources.[23] In this study, we used the Persian version of the WAI questionnaire, which has been validated for ergonomic purposes.[13,17] It consists of seven dimensions with a total of 11 questions, covering factors such as current workability, physical and mental demands, number of diseases, work impairment, sick leaves, future workability prediction, and intellectual and mental capacities. Each dimension has a different score, and a higher score indicates better workability. The total WAI score ranges from 7 to 49 and are classified into four levels: poor, moderate, good, and excellent. This classification helps determine the workers' current ability to work and predict their health risk level.[15]

Measurement of maximum aerobic capacity ($VO_{2\,max}$)

In this study, we measured physiological indicators ($VO_{2\,max}$, maximal heart rate, and physical work capacity [PWC]) using validated instruments and procedures. We used the step test protocol developed by McArdle *et al*.[24] to indirectly calculate $VO_{2\,max}$. Participants wore a Polar OH1 optical heart rate sensor to monitor their heart rate during the test [Figure 1a]. The test involved stepping on a wooden step for 3 min [Figure 1b], following a specific rate determined by a metronome. After the exercise, the heart rate was measured from the 5th to the 12th s during the recovery period, and the pulse rate was multiplied by 4 to obtain beats per minute (bpm). $VO_{2\,max}$ was calculated using a specific equation.

For males: $VO_{2\,max} = 111.33 - (0.42 \times \text{pulse rate beats/min})$.

For females: $VO_{2\,max} = 65.81 - (0.1847 \times \text{pulse rate beats/min})$ (mL/kg/min).

The PWC was found to be 33% of $VO_{2\,max}$, and HR_{max} values were estimated for each subject using the given equation. $HR_{max} = 220 - \text{Age (years)}$.

Measurement of the cognitive ability

The cognitive ability of each subject was assessed using the psychomotor vigilance test (PVT). PVT is a RT test commonly used to evaluate alertness, attention, sleep, and cognitive function disorders. In the test, a visual stimulus appeared randomly on the screen every 2–10 s and the subject responded by pressing a button. The number of misses or lapses and the time interval between stimulus appearance and response were recorded in milliseconds. Each participant completed the PVT test once, which consisted of 180 stimuli. The total duration of the test was 68 min, but an abbreviated version that lasting around 11 min was done just after the step test.

Data analysis

Descriptive statistics, such as measures of central tendency and dispersion for quantitative variables, as well as frequency and percentage for qualitative variables, were used to describe the data. In addition, an independent *t*-test, ANOVA, and Pearson correlation tests were performed to analyze the data. All statistical tests were conducted in SPSS version 22 (IBM com, Chicago, USA), and $P < 0.05$ was considered statistically significant.

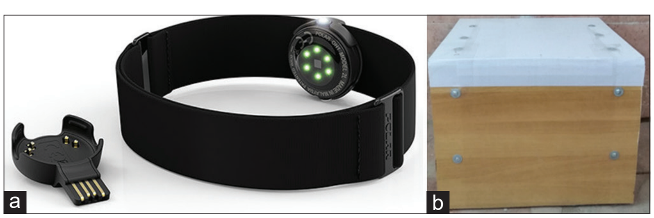

Figure 1: (a) PolarOH1-optical heart rate sensor, (b) step with 41.3 cm height

Results

Table 1 presents participant demographics and anthropometric characteristics. Table 2 displays mean, standard deviation, maximum, and minimum values for physiological, cognitive variables, and WAI. In addition, Table 3 depicts the correlation between each variable and $VO_{2\,max}$.

As shown in Table 3, correlations were found between anthropometric and cognitive variables and $VO_{2\,max}$ ($P < 0.05$).

The relationship between workers' workability and personal and physiological characteristics

In this study, the relationship between workability and personal and physiological characteristics was investigated. No significant correlation was found between PWC and WAI, as well as between WAI and variables such as age,

Table 1: Description of the participants' personal data

Variable	*n*	Mean±SD	Range
Age (years)	60	37.17±6.3	27–51
Height (cm)	60	174.2±7.3	159–192
Weight (kg)	60	77.56±11.3	53–98
BMI	60	25.5±2.9	18.1–30.99
Work experience (years)	59	10.85±6.7	2.5–28

BMI: Body mass index, SD: Standard deviation

Table 2: Description of different variables of participants

Variable	Mean±SD	Range
VO_2max (mL/kg.min)	45.54±6.13	34.47–58.53
PWCmax (kcal/min)	17.68±3.53	9.31–25.95
PWC (kcal/min)*	5.84±1.14	3.21–8.56
Reaction time (ms)	337.82±29.93	239–412
True response	96.02±3.53	82–100
Percentage error	3.98±3.53	0–18
WAI	42.76±5.02	28–49

*PWC=PWCmax×0.33. WAI: Workability index, SD: Standard deviation, VO_2max: Maximum aerobic capacity, PWC: Physical work capacity

Table 3: Correlation between different variables and VO_2max

Variable	Correlation coefficient	*P*
Age	0.11	0.39
Height	0.56	<0.001
Weight	0.77	<0.001
BMI	0.59	<0.001
Reaction time	0.3	0.02
Percentage error	0.6	0.02
WAI	0.12	0.3

BMI: Body mass index, WAI: Workability index

Table 4: Comparison of employee's physical work capacity with standardized values for their jobs metabolic equivalent

Job	Job code	Required energy (MET)	BMR mean (kcal/min)	PWC mean (kcal/min)	PWC mean (MET)	Substrate
Technical	11130	3.5	1.95	6.11	3.13	+0.37
Production	11610	3	1.86	5.73	3.08	−0.08
Laboratory	11580	1.5	2.02	5.98	2.96	−1.46
Office	11585	1.5	1.8	5.72	3.18	−1.68
Security	11525	2.5	2.14	6.54	3.06	−0.56
Warehousing	11610	5.3	1.58	3	3.35	−0.35
Services	11820	5	1.84	5.34	2.9	+2.1

PWC: Physical work capacity, MET: Metabolic equivalent

BMI, and smoking ($P > 0.05$). However, an association was discovered between marital status, weekly exercise hours, and WAI ($P < 0.05$).

Evaluation of physiological fitness

Based on cardiopulmonary fitness standards,[25] the participants' $VO_{2\ max}$ values were determined for different departments in the factory. The average values were as follows: technical (46.25 ± 7.08), production (45.86 ± 5.07), laboratory (43.02 ± 6.16), office (45.11 ± 6.92), security (44.97 ± 4.84), warehouse (49.48 ± 5.5), and services (42.87). All employees were classified as having "good" cardiovascular status based on their age ranges. It is possible to categorize and interpret the physiological ability and cardiovascular fitness of workers using the average $VO_{2\ max}$ index and the age range of people.

Using the job activity coding system,[26,27] the required standard energy level was subtracted from the mean working capacities of employees in each department [Table 4].[28] This revealed a physiological mismatch between the nature of work and the characteristics of employees in the service and security department.

Discussion

This study investigated the relationship between participants' aerobic capacity, cognitive performance, and workability. The mean WAI was found to be 42.76 ± 5.02, which falls within the acceptable range suggested by the Finnish Institute of Occupational Health.[15] Of the employees, 11.7% had moderate workability, 31.7% had good workability, and 56.7% had excellent workability. Workability is a complex issue influenced by various factors such as employee characteristics and job-related factors. Identifying and addressing contributory factors could improve lower levels of workability.[29] Previous studies have measured WAI in different occupations, and most reported acceptable levels (WAI < 36). For instance, the WAI was reported to be 40.9 among Dutch construction workers, 40.9 among Finnish police officers, and 40.6 among Belgian firefighters, respectively.[30]

The Pearson correlation coefficient was used to examine the association between workability and each of the following variables: age, work experience, BMI, work capacity, and the hours of exercise per week. No statistically significant relationship was observed between the participants' workability and their age, work experience, BMI, and work capacity ($P > 0.05$). However, a strong link between workability and exercise hours per week and marital status was identified ($P < 05$). These results correspond to those of Hajizadeh *et al*. who discovered no correlation between WAI, age, or work experience.[29]

To assess cognitive ability, the researchers used the psychomotor vigilance test (PVT). The mean test time was 337.82 ms and the number of correct answers was 96.02. Using the Pearson correlation test, they found a weak but statistically significant positive association between PVT and $VO_{2\ max}$ ($r = 0.3$, $P = 0.02$), as well as between PVT and PWC ($r = 0.263$, $P = 0.04$). Previous research has also shown that individuals with better physical fitness tend to have improved cognitive performance, including sustained attention and quicker RT.[19] Qasemy *et al*. found a similar positive relationship between physical and cognitive abilities, supporting the findings of this study.[10]

The mean and standard deviation of the $VO_{2\ max}$ index of workers in terms of mL/kg/min as well as L/min were 45.54 ± 6.13 and 3.53 ± 0.71, respectively. These values exceeded those of other employees, particularly industrial sector employees (36.3 ± 9.72), (38.4 ± 7.48),[5,31] firefighters (36.3 ± 8.28),[21] military personnel (29.93 ± 2.37),[32] medical emergency students (3.15 ± 0.5 L/min),[33] and less than medical students (45.66 ± 8.96).[34] The participants' cardiovascular fitness level, based on the study by McArdle *et al*., was categorized as good for their age range.[25] A higher respiratory capacity was associated with lower blood pressure, heart rate, and stress levels and could potentially alleviate muscle tension and musculoskeletal problems.[35] According to this study, $VO_{2\ max}$ was significantly correlated with the participants' height, weight, and BMI. It is known that factors such as age, weight, BMI, and physical activity levels can affect an individual's aerobic capacity.[3,9] Therefore, the observed disparities can be explained. In addition, a significant association was found between $VO_{2\ max}$ and RT ($r = 0.3$, $P = 0.02$), as well as between $VO_{2\ max}$ and error rate ($r = 0.6$, $P = 0.02$).

The mean permissible workload for employees was 5.84 kcal/min, with no significant difference between employees in different jobs. Work physiology experts suggest that for continuous work over 8 h, the workload should be one-third or less than the individual's physiological capacity (25% for 12 h of work).[36] However, when comparing the mean workload with respect to different jobs, there was an incompatibility among the characteristics of employees, especially in laboratory, office, and service work. According to physiological,[26,27] service personnel had a workload that was less than their physical capacity, whereas office and laboratory personnel had workloads that exceeded their physical capabilities. Therefore, measures should be taken to achieve a proper balance. Another study also found similar mismatches among manufacturing business personnel.[5] To promote the physical and mental health of employees and adhere to ergonomics principles, individuals should be recruited based on job demands. For future research in this field, it is recommended to conduct the investigations on a larger sample size and to carry out several specialized physical activity assessments.

Conclusion

To ensure a healthy workforce, officials and policymakers should consider employees' physical traits and fitness levels. This can be achieved by implementing robust selection processes, standardizing employment procedures, and providing sports and activity facilities. By prioritizing employees' physiological well-being, a balanced and ergonomic workplace can be established.

Acknowledgments

The authors would like to thank Lorestan University of Medical Sciences and also the dairy industry staff.

Financial support and sponsorship

This research was supported by Lorestan University of Medical Sciences, grant number 1397-1-99-1208.

Ethics code

Ethical approval for this study (IR.LUMS.REC.1399.236.) was provided by the Ethical Committee of Lorestan University of medical sciences, Khoramabad, on March 2021.

Conflicts of interest

There are no conflicts of interest.

References

1. Habybabady RH, Ghaderi N, Rahmani R, Mohammadi M. Estimation of maximum aerobic capacity and its related factors using treadmill test in firefighters of Zahedan. North Khorasan J Med Sci 2018;10:1-8.
2. Vigatto R, Alexandre NM, Correa Filho HR. Development of a Brazilian Portuguese version of the oswestry disability index: Cross-cultural adaptation, reliability, and validity. Spine (Phila Pa 1976) 2007;32:481-6.
3. Daneshmandi H, Choobineh AR, Rajaei Fard AR. Estimation of aerobic capacity and determination of its associated factors among male workers of industrial sector of Shiraz city, 2010. Iran Occup Health 2011;8:48-58.
4. Yakasai AM, Maharaj SS, Shittu A, Zakari UU, Danazumi MS. Measuring cardiorespiratory endurance of sawmill workers using a step test. Crit Rev Phys Rehabil Med 2019;31:273-80.
5. Hosseinabadi S, Hamidi BP, Ebrahimi H, Barkhordari A, Raie BT. Estimation of aerobic capacity (VO2 max) and physical work capacity in laborers. Knowl Health 2013;8:131-7.
6. Farhadi S, Hesam G, Moradpour Z, Abazari M, Babayi Mesdaraghi Y. Estimating the maximum aerobic capacity of fire fighters using the step test; a case study with height adjustable steps. J Ergon 2016;4:60-6.
7. Chatterjee P, Banerjee AK, Das P, Debnath P. A regression equation for the estimation of maximum oxygen uptake in Nepalese adult females. Asian J Sports Med 2010;1:41-5.
8. Santtila M, Häkkinen K, Pihlainen K, Kyröläinen H. Comparison between direct and predicted maximal oxygen uptake measurement during cycling. Mil Med 2013;178:234-8.
9. Hosseini S, Reza M, Ravandi G, Khanjani N. Estimating aerobic capacity (VO2-max) using a single-stage step test and determining its effective factors. Int J Occup Hyg 2017;9:201-6.
10. Qasemy R, Saremi M, Kavousi A. Relation between maximum aerobic capacity with cognitive ability and academic performance. Iran Occup Health 2018;15:99-106.
11. Maghsoudipour M, Shabani H, Najafabadi MG, Bakhshi E, Coh P. The relationship between emotional intelligence, reaction time, aerobic capacity and performance in female track and field athletes at the universities of Tehran. Work 2018;61:173-9.
12. Prieske O, Dalager T, Looks V, Golle K, Granacher U. Physical fitness and psycho-cognitive performance in the young and middle-aged workforce with primarily physical versus mental work demands. J Public Health (Bangkok) 2019;29:75-84.
13. Mazloumi A, Kazemi Z, Foroushani AR, Eyvazloo M. Validation and reliability study of Farsi version of work ability index questionnaire. Sci J Sch Public Health Inst Public Health Res 2014;12:61-74.
14. Tuomi K, Illmarinen J, Jahkola A, Katajarinne L, Tulkki A. Work Ability Index. 2nd ed. Helsinki: Finnish Institute of Occupational Health; 2006. p. 177-81.
15. Adel M, Akbar R, Ehsan G. Validity and reliability of work ability index (WAI) questionnaire among Iranian workers; a study in petrochemical and car manufacturing industries. J Occup Health 2019;61:165-74.
16. Lundin A, Leijon O, Vaez M, Hallgren M, Torgén M. Predictive validity of the Work Ability Index and its individual items in the general population. Scand J Public Health 2017;45:350-6.
17. Yousefi B, Ahmady B, Hassani Z. The validity and reliability of the Persian version work ability index and its relationship with physical fitness indicators among employees in Kermanshah. Sport Manage Stud 2017;9:171-90.
18. Kuhl CC, Medeiros TE, Batista MM, Pauli PH, Martins MV, Queiroga MR, *et al.* Relationship of simple reaction time and aerobic and anaerobic capacities with performance of recreational adult orienteers. Rev Bras Cineantropometria Desempenho Hum 2019;21:1-12.
19. Luque-Casado A, Perakakis P, Hillman CH, Kao SC, Llorens F, Guerra P, *et al.* Differences in sustained attention capacity as a function of aerobic fitness. Med Sci Sports Exerc 2016;48:887-95.
20. May RW, Hutchinson M, Seibert GS, Fincham F, Sanchez-Gonzalez MA. Improving cognitive performance via high intensity interval aerobic exercise: A randomized controlled trial. J Exerc Physiol 2017;20:141-6.
21. Firoozeh M, Saremi M, Maleki A, Kavousi A. Investigation into maximal aerobic capacity and its associated factors in firefighters. Iran Occup Health 2015;12:312-4.
22. Afshari D, Angali KA, Ahangar AS, Pour SM, Amirmoezi S. Effects of anthropometric and demographic factors on physical work capacity of students of Ahvaz university of medical sciences. J Occup Hyg Eng 2018;4:12-9.
23. Hetzel C, Baumann R, Bilhuber H, Mozdzanowski M. Determination of work ability by a Work Ability Index short form ("WAI-r"). ASU Int 2014; ASU International 2014;10:1-9.
24. McArdle WD, Katch FI, Pechar GS, Jacobson L, Ruck S. Reliability and interrelationships between maximal oxygen intake, physical work capacity and step-test scores in college women. Med Sci Sports 1972;4:182-6.
25. McArdle WD, Katch FI, Katch VL. Exercise Physiology: Nutrition, Energy, and Human Performance. Wolters Kluwer: Lippincott Williams & Wilkins; 2010.
26. Ainsworth BE, Haskell WL, Leon AS, Jacobs DR Jr., Montoye HJ, Sallis JF, *et al.* Compendium of physical activities: Classification of energy costs of human physical activities. Med Sci Sports Exerc 1993;25:71-80.

27. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, *et al.* Compendium of physical activities: An update of activity codes and MET intensities. Med Sci Sports Exerc 2000;32:S498-504.
28. Kumahara H, Yoshioka M, Yoshitake Y, Shindo M, Schutz Y, Tanaka H. The difference between the basal metabolic rate and the sleeping metabolic rate in Japanese. J Nutr Sci Vitaminol (Tokyo) 2004;50:441-5.
29. Hajizadeh F, Motamedzade M, Golmohammadi R, Soltanian A. Work ability assessment and its relationship with severity of musculoskeletal disorders among workers in a cement plant Farideh. J Occup Hyg Eng 2015;2:15-22.
30. Habibi E, Dehghan H, Zeinodini M, Yousefi H, Hasanzadeh A. The relation between work ability index and physical work capacity based on fox equation for VO2 max in male nursing staff of Isfahan hospitals, Iran. Int J Prev Med 2012;7:606-14.
31. Choobine A, Tabatabai H, Barzideh M. Estimation of aerobic capacity (VO2-max) and study of its associated factors among male workers of industrial factories in Sepidan/Fars province 2009. Sci Med J 2011;10:1-12.
32. Valipour F, Khavanin A, Asilian H, Pourtaghi GH, Mohebi H, Joneidi N, *et al*. Measuring the physical work capacity of the revolutionary guards infantry in normal, very hot and humid laboratory climates. Journal of Military Medicine 2007;9:67-72.
33. Heydari P, Varmazyar S, Nikpey A, Variani AS, Jafarvand M. Step test: A method for evaluating maximum oxygen consumption to determine the ability kind of work among students of medical emergencies. Electron Physician 2017;9:4020-6.
34. Nabi T, Rafiq N, Qayoom O. Rationale for near total thyroidectomy in patients with nodular Goitre. Int J Biomed Adv Res 2015;6:418-21.
35. Ritvanen T, Louhevaara V, Helin P, Halonen T, Hänninen O. Effect of aerobic fitness on the physiological stress responses at work. Int J Occup Med Environ Health 2007;20:1-8.
36. Toomingas A, Mathiassen SE, Tornqvist EW. Occupational Physiology. Taylor and Francis Group: CRC Press; 2016.