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Original

# Association between Maximum Aerobic Power and General Health in Women

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## Abstract

**Background:** The highest aerobic capacity (VO2max) is one of the criteria that can be used to create a balance between work and worker. To maintain the health and physical capacity of individuals, as well as to increase production and profitability, physical work capacity (PWC) can be used to put individuals in jobs proportional to their capacities. **Methods:** This cross-sectional study was performed on 120 women working in hospitals aged 21-49 years old. Individuals were evaluated by a single-stage Ebbeling test. A questionnaire about general health, job fatigue and job satisfaction was used, along with a treadmill. Data were analyzed by SPSS V22 software using the Pearson correlation and t-test. **Results:** According to the results, the highest aerobic capacity, physical working capacity and general health were $38 \cdot 89(1 \cdot 85)$ ml/kg body weight per minute, $4 \cdot 10(0 \cdot 47)$ kcal/min and $25 \cdot 43(12 \cdot 09)$ respectively, and mean and standard deviation of fatigue and job satisfaction scores were $85 \cdot 87(32 \cdot 35)$ and $57 \cdot 47(13 \cdot 01)$ respectively. In this study, there was a significant relationship between VO2max and age, weight, body mass index (BMI), fatigue and job satisfaction. **Conclusion:** According to the results, since fatigue and job satisfaction are related to workers' VO2max, it is recommended that, in addition to considering the aspects of physical fitness in the workplace, special attention should be paid to mental aspects, since they affect the physical and, consequently, the productivity of workers.

**Keywords:** Maximum aerobic capacity; Physical work capacity; Hospital women employees; General health

## Introduction

The main objective of ergonomic science is to create a balance between people and their environment. For this reason, tools for assessing the effectiveness of ergonomic interventions are needed to provide the necessary information on proportionality vs. disproportionality.[1] To provide such a ratio, it is necessary to determine the energy consumption of different occupations and, on the other hand, to measure the physical capacity of the employees. Therefore, measuring physical fitness is one of the key issues of ergonomic science, which has been emphasized by the International Labor Organization.[2]

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In other words, by measuring the mental, physical and physiological characteristics of humans, all related factors can be tailored to fit the work, along with his measurements and physiological capacities.[3] In Iran, there is no accurate statistics on the employment rate of the workforce in the treatment sector. In Europe, however, women account for the highest percentage of civilian personnel. As much as 75% of these forces are women. in addition, the distinction between work in the hospital and the production industries is inevitable.[4]

Hospital workers are required to work round the clock. [5] Working in the field of treatment, and, in particular, nursing, is one of the areas where physical and psychological stimuli (overtime, difficulty and excessive workload, unwanted overtime) threaten comfort and quality of life.[6] The disparity between human abilities and the type of work that they do causes problems and issues.[7] One of the important aspects of ergonomics and organizational management is work physiology,[8,9] which involves the selection of the required workforce and the work-life balance of individuals with physical and mental capabilities. By measuring individuals physiologically, one can place each person in a career appropriate for his physiological threshold, in addition to maintaining his health. Further, physical capacity, production and productivity will also increase.[3] In 1962, Professor B. Bink coined the term Physical Work Capacity (PWC), which refers to the maximum amount of energy that a person can perform during his eight-hour shift without sacrificing his own health.[3]

VO2-max is the highest amount of oxygen that can be absorbed by the respiratory tract and transmitted through the blood to the muscles, and is considered as a standard for measuring the practical limits of the cardio-respiratory system.[3,10] VO2-max is usually expressed in liters or milliliters of oxygen per kg of body weight per minute (l kg-1 min-1 or ml kg-1 min-1).[11] VO2-max varies between different individuals and is affected by various factors such as physical, psychological, environmental and genetic.[10,11,12] Aerobic capacity can be measured directly or indirectly. Direct assessment of aerobic capacity is commonly used in young and athletic subjects. Indirect measurement, which has a lower physiological pressure on a person, is more suitable for working communities.[11]

From an economic standpoint, the correct assessment of employees' ability to work is important for the employer, and strengthening it is one of the ways to increase the productivity of human resources in industries and organizations. The ability to work is the basis of the design of work stations and the screening of potential employees for specific occupations. In other words, if the physical and psychological abilities of workers and employees are not in line with their occupational needs, it leads to safety and health problems, reduces production, and results in increased dismissal of workers and employees, which is adds to expenditure.[13]

Despite numerous studies on male hospital and non-hospital workers, no study has been conducted to determine the relationship between VO2MAX physical factors and psychological factors (general health) in women working in hospitals. This study aimed to measure this relationship. If there is a direct relationship between mentioned factors, in addition to considering the physical aspects of balance of work, special attention should be paid to the psychological suitability of work with female personnel. The aim of this study was to determine the maximum aerobic power (VO2max), physical working capacity (PWC) and general health (GH) and to identify underlying factors such as age, weight, BMI, fatigue and job satisfaction in female employees working in Isfahan hospitals.

## Methods

This cross-sectional descriptive-analytic study was carried out on 120 women working in Isfahan hospitals in 2014. The sample size needed for this study with a confidence level of 95% and a durability

interval of d = 2, and considering the possibility of data loss using the formula N=z2*sd2/d2, was estimated to be 96. The sample, following the model of previous studies, was selected randomly from a population aged 20 to 49 years.[6,14] To ensure the results achieved and to increase the credibility of the study, the sample size was increased to 120 people. It should be noted that the participants filled out an informed consent form before completing the tests and were assured that the collected data would be kept confidential and would not be provided to any entity. Also, those who suffered from cardiovascular problems or respiratory problems were excluded from the study. At the beginning of the test, a questionnaire for gathering information such as additional employment, exercise patterns, whether participants smoke, marital status, work system, type of work and level of education was given to each individual. In this study, a portion of the data was collected by a questionnaire and another part by a direct measurement, which is described below:

In this study, the GHQ-28 questionnaire was used to determine the general health of individuals. Validity and reliability of the questionnaire have been confirmed in several studies.[15] The 28-item form of the General Health Questionnaire was developed by Goldberg DP and Hillier VF in 1979, which includes four subscales of physical symptoms, anxiety and sleep disorders, social dysfunction and severe depression.[15] In these subscales, those who score 6 or less are considered healthy, while those who score 7 or higher are suspected of being impaired. With this delineation, the sensitivity and specificity of the test were 84.7(2.7) and 93.7%(2.7) respectively, and the overall classification error was 8.2 (2.7).[16] Also, in this method, the score for those who score 23 or less in overall health are considered healthy and those who score 24 or more are suspected of having the disorder. Sensitivity, specificity and error rate of general classification with this cutting score were 70.5 (2.4), 92.3 (2.4) and 12.3 (2.4) respectively.[16]

Brayfield AH and Rothe Job Satisfaction Questionnaire: The questionnaire was created by Brayfield AH, Rothe in 1951 to measure job satisfaction and includes 19 5-option questions. In this questionnaire, respondents are asked to identify their feelings and attitudes toward their jobs on a 5-point scale. For the options strongly disagree, disagree, no idea, agree and strongly agree, the score of 1, 2, 3, 4, and 5 are assigned, respectively. The rest of the items are scored in reverse. The reliability of the Brayfield AH and Rothe job satisfaction questionnaire has been confirmed in several studies in Iran.[17]

Swedish Occupational Fatigue Questionnaire (SOFI-20): The Persian version of the Swedish Job Fatigue Questionnaire has 20 items and 5 dimensions: "Lack of energy", "Physical effort", "Physical discomfort", "Lack of motivation" and "Sleepiness". Each item is rated using an 11-degree Likert scale from zero (completely disagree) up to 10 (completely agree). The minimum and maximum scores are 0 and 200 respectively. The reliability and validity of the questionnaire are confirmed in various studies.[18]

### Method for measuring the maximum aerobic capacity (VO2-max)

In this study, the VO2-max was determined with the treadmill exercise test (using a T 9670 treadmill) and Ebbeling method.[19]

To determine the PWC, the obtained VO2max (in l min-1) will be multiplied by 5 to achieve maximum physical ability (AC). Finally, the physical working capacity of each person was determined from the equation PWC = AC × 0.33 in kilocalories per minute.[20]

The height and weight of the subjects in the study were measured in light clothing, without shoes or gloves. For measuring heartrate and blood pressure, a polar sport tester and the blood pressure gauge device were used respectively. Body mass

index was also obtained by dividing the weight by height and in square kilograms.

After experiments, the collected data were analyzed by SPSS software version 22 using the t-test with two independent samples, Spearman's rank-order correlation, analysis of variance, and the correlation coefficient formula. It should be noted that the quantitative data from the mean and standard deviation with 95% confidence intervals were used, and for the qualitative data, 95% confidence intervals were used.

## Results

The average age, work history, weight, height, and body mass index of the subjects are shown in Table 1. Also, the number and percentage of studied variables (general health, satisfaction, and occupational stress) has been shown in the participants in Table 2.

The relationship between VO2max and age, weight, height, BMI and general health score is shown in Table 3. As shown in this table, with the increase in age, the maximum aerobic power in humans is reduced. In this table, based on the general health score and its sub-indices, the difference in mean of maximum aerobic capacity in healthy and suspected cases is statistically significant, so that the maximum aerobic capacity is higher in healthy people.

**Table 1.** Average demographic information, maximum aerobic capacity, physical activity capacity, general health score and sub-scales, fatigue and job satisfaction in the studied population.

| Variable | mean | SD | Min | Max |
|---|---|---|---|---|
| Age in years | 34.47 | 6.29 | 21 | 49 |
| Height in meters | 1.61 | 0.05 | 1.50 | 1.78 |
| Weight in kilograms | 64.06 | 8.22 | 42 | 88 |
| BMI in kilograms square meters | 24.52 | 2.95 | 17.58 | 33.53 |
| Work experience | 11.20 | 6.71 | 2 | 23 |
| VO2MAX in ml min-1 kg-1 | 38.89 | 1.85 | 33.07 | 45 |
| VO2MAX in l min-1 | 2.48 | 0.28 | 1.70 | 3.21 |
| PWC in kcal min-1 | 4.10 | 0.47 | 2.80 | 5.30 |
| Overall health score | 25.43 | 12.09 | 6 | 70 |
| Physical symptoms scale | 8.20 | 3.98 | 00 | 17 |
| Anxiety symptoms and sleep disorders | 7.10 | 4.51 | 00 | 21 |
| Social disorder scale | 6.92 | 2.78 | 1 | 18 |
| The scale of symptoms of depression | 3.20 | 3.66 | 00 | 19 |
| Heartbeat | 127.30 | 8.04 | 109 | 151 |
| Job fatigue | 85.87 | 32.35 | 16 | 184 |
| Job satisfaction | 57.48 | 13.1 | 24 | 80 |

**Table 2.** The percentage and frequency of demographic information of the participants

| Variable | Subgroup | Number | Percent |
|---|---|---|---|
| Second job | Yes | 24 | %20 |
| | No | 96 | %80 |
| Exercise | Yes | 41 | %34.2 |
| | No | 79 | %65.8 |
| Smoke | Yes | 9 | %7.5 |
| | No | 111 | %92.5 |
| Marital status | Single | 24 | %20 |
| | Married | 96 | %80 |
| Work system | Day work | 66 | %55 |
| | Shift | 54 | %45 |
| Kind of work | Official | 45 | %37.5 |
| | Executive | 75 | %62.5 |
| Education | Diploma and lower | 23 | %19.2 |
| | Associate degree | 14 | %11.07 |
| | Bachelor's degree and higher | 83 | %69.2 |

**Table 3.** Relationship between age, weight, height, BMI and general health score with VO2max

| Variable | Group | Number | Percent | VO2max (ml kg-1 min-1) Mean | SD | MIN | MAX | *P*-Value* |
|---|---|---|---|---|---|---|---|---|
| Age | 20-29 | 37 | %30.8 | 40.28 | 1.59 | 37.11 | 45 | 0.001 |
| | 30-39 | 47 | %39.2 | 38.74 | 1.67 | 33.07 | 41.16 | |
| | 40-49 | 36 | %30 | 37.66 | 1.34 | 33.92 | 39.87 | |
| Weighted groups | ≤55 | 22 | %18.3 | 40.03 | 1.60 | 37.65 | 45 | 0.001 |
| | 56-64 | 41 | %34.2 | 38.97 | 1.33 | 36.78 | 43.75 | |
| | 65-69 | 27 | %22.5 | 39.01 | 1.73 | 34.42 | 41.97 | |
| | ≥70 | 30 | %25 | 37.84 | 2.23 | 33.07 | 42.29 | |
| Height groups in cm | ≤155 | 18 | %15 | 39.20 | 1.03 | 37.65 | 41.16 | 0.022 |
| | 156-160 | 38 | %31.6 | 39.24 | 1.57 | 36.78 | 45 | |
| | 161-165 | 32 | %26.7 | 38.02 | 2.35 | 33.07 | 43.75 | |
| | ≤166 | 32 | %26.7 | 39.17 | 1.76 | 34.11 | 42.29 | |
| BMI groups | 18.5< | 1 | %0.8 | 39.67 | 0 | 39.67 | 39.67 | 0.001 |
| | 18.5-24.9 | 70 | %58.3 | 39.28 | 1.75 | 34.42 | 45 | |
| | 25-29.99 | 40 | %33.3 | 38.71 | 1.55 | 33.92 | 41.41 | |
| | ≥30 | 9 | %7.5 | 36.62 | 2.36 | 33.07 | 41.16 | |
| General health score | 0-23 | 64 | %53.3 | 39.73 | 1.60 | 36.49 | 45 | 0.001 |
| | 24-84 | 56 | %46.7 | 37.93 | 1.66 | 33.07 | 40.69 | |
| Physical symptoms scale | 0-6 | 51 | %42.5 | 39.57 | 1.86 | 34.11 | 45 | 0.001 |
| | 7-21 | 69 | %57.5 | 38.39 | 1.69 | 33.07 | 41.94 | |
| Sleep | 0-6 | 65 | %54.2 | 39.52 | 1.59 | 36.49 | 45 | 0.001 |
| | 7-21 | 55 | %45.8 | 38.15 | 1.88 | 33.07 | 41.94 | |
| Disruption of social function | 0-6 | 49 | %40.8 | 39.63 | 1.54 | 36.49 | 45 | 0.001 |
| | 7-21 | 71 | %59.2 | 38.38 | 1.89 | 33.07 | 43.75 | |
| The scale of symptoms of depression | 0-6 | 100 | %83.3 | 39.15 | 1.68 | 33.92 | 45 | 0.001 |
| | 7-21 | 20 | %16.7 | 37.59 | 2.14 | 33.07 | 40.46 | |

* statistical test: t-Test** p<0.05

**Table 4.** Relationship between heart rate, fatigue and job satisfaction with VO2max

| Variable | VO2max (ml kg-1 min-1) Mean | SD | MIN | MAX | R Correlation Coefficient | *P*-Value* |
|---|---|---|---|---|---|---|
| Heartbeat | 127.30 | 8.04 | 109 | 151 | -0.034 | 0.714 |
| Job fatigue | 85.87 | 32.35 | 16 | 184 | -0.335 | 0.001 |
| Job satisfaction | 57.48 | 13.01 | 24 | 80 | 0.331 | 0.001 |

*p<0.05

As shown in Table 4, there is a negative correlation between job fatigue and VO2max and decreases with increasing this VO2max variable, but there is a positive correlation between job satisfaction and VO2max. As a result, there is a significant relationship between job satisfaction and occupational exhaustion with VO2max. With the increase in occupational fatigue, the maximum aerobic capacity is reduced, as well as by increasing job satisfaction, the maximum aerobic capacity increases. Meanwhile, there was no significant relationship between heartrate and maximum aerobic capacity in this study. P = 0.714.

In Table 5, the relationship between second job, exercise, whether participants smoked, marital status, work system and type of work with VO2max were investigated. As can be seen in this table, there is a statistically significant relationship between the two variables of career, marriage, and work system with aerobic capacity. Meanwhile, aerobic capacity is higher among people in one job. Also, in day workers and single people, aerobic capacity is higher than that of married and shift workers. In this study, there was no relationship between education level, type of work and smoking history with aerobic capacity.

**Table 5.** The relationship between the second job, exercise, smoking, marriage, work system and type of work with VO2max

| Variable | Subgroup | VO2max (ml kg-1 min-1) Mean | SD | *P*-Value* |
|---|---|---|---|---|
| Second job | Yes | 37.78 | 1.76 | 0.001 |
| | No | 39.17 | 1.78 | |
| Exercise | Yes | 39.68 | 1.82 | 0.001 |
| | No | 38.49 | 1.75 | |
| Smoke | Yes | 38.90 | 1.12 | 0.989 |
| | No | 38.89 | 1.90 | |
| Marital status | Single | 40.17 | 1.57 | 0.001 |
| | Married | 38.57 | 1.79 | |
| Work system | day work | 39.27 | 2.01 | 0.013 |
| | shift | 38.43 | 1.53 | |
| Type of work | Official | 38.72 | 1.31 | 0.429 |
| | Executive | 39 | 2.12 | |

p<0.05*

## Discussion

In the present study, the mean age of the studied population was 34.47 years and most of the subjects were in the natural range of BMI. Mean VO2max and PWC were 38.89 ml kg-1 body weight per minute and 4.10 kcal min-1, respectively. According to Bugajskaa et al., the mean VO2max values were 9.8 (6.33), which is slightly different from the current study.[21] Also, the mean of total general health, fatigue and job satisfaction in the study population was **25.43(12.09)**, **85.87(32.35)**, and **57.47(13.01)**. Based on the results of the general health score, it can be judged that the ratio of healthy people with a low percentage is more than those who are suspected of mental illness. The results of this study showed that among the subscales of general health, the mean scores below the scale of physical symptoms, sleep, and anxiety and disruption of social function in the subjects exceeded the delineation (6 points), and only the mean score and only the sub-scales of depression symptoms are lower than the delineation.

The results of this study are consistent with the findings of the study by Kessler et al. in the two sub-comparisons of physical symptoms and anxiety.[22] This study is less consistent, however, with the results of Stanfield et al. who show in their study even though they have less work experience, fewer psychiatric disorders are observed in women.[15] In this study, as well as the results of the research by Fakhar et al., there is a statistically significant relationship between psychiatric disorders in married and single people, and married people are more likely to experience mental disorders.[14] In the study of Bugajskaa et al., it was observed that aerobic capacity decrease with the increase of age, which is consistent with the results of the present study. [21]

In this study, the mean values and standard deviations of VO2-max in ml kg-1 min-1 were higher than those obtained in the Bugajskaa et al. study.[21] Considering the calculation of physical working capacity (PWC) by the highest aerobic capacity, it can be concluded that the physical working capacity in Kcal min-1 obtained in this study is the same as the mean of the maximum aerobic capacity of the mean obtained in the study of Bugajskaa et al.[21] In contrast to the research of Moghiseh et al., no significant correlation was found between the maximum aerobic capacity of VO2-max and heart rate in this study.[23] The results of this study showed that increasing the work record and BMI did not increase the overall health score. These findings are not consistent with the results of other studies.[16,24] Also, according to the results of this study, there is a significant relationship between the aerobic capacity of individuals with job satisfaction and the feeling of fatigue during work, which is contrary to the findings of other studies.[1,25] These differences seem to be due to differences in the statistical society.

## Conclusion

This study showed that there is a significant statistical relationship between mental health and maximum aerobic capacity. The results of this study confirmed the findings of previous studies on the association of maximum aerobic capacity with weight, height, age, and body mass index. Also, in this study, job fatigue and job satisfaction are among the factors affecting general health and

aerobic capacity. It seems that mental health in women working in hospitals requires special consideration. In this area quantitative studies are needed regarding the maximum aerobic capacity, physical capacity, and general health and parameters affecting them, and it is recommended that more research be done by the researchers. Also, in addition to considering the physical aspects, psychological appropriateness of work with the personnel also should be specially taken into consideration.

## Conflict of interest

The authors declare no conflict of interests

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