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Study of Vo_2-max in Farmers of Sistan Region Province in 2017

Farhad Saffarian and Maryam Ghaljahi[1]*

Environmental Pollution, Islamic Azad University Kermanshah Branch, Kermanshah, Iran
[1]Department of Occupational Health Engineering, School of Health, Zabol University of Medical Sciences, Zabol, Iran
✉ occmgh@gmail.com

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Abstract: Study on maximal aerobic capacity is important to make physiological adaptation between worker and work. This study aims to investigate maximal aerobic capacity and physical work capacity of male farmers in Sistan region and determining affective factors of that on workers. In this descriptive cross-sectional study, 400 male farmers of Sistan region were randomly selected and participated in this research. A questionnaire comprising two parts is used as data collection tool. The first part deals with demographic features and is completed by interview and in the second part of questionnaire parameters including age, height, weight, waist-hip ratio, BMI and number of heartbeats are recorded. Measurement of maximal aerobic capacity was performed using Tuxworth and Shahnavaz method. Correlation between Vo_2-max and weight and height variables was accomplished using linear regression analyses and comparing the mean Vo_2-max with BMI and age parameters in ternary and quaternary groups and comparing the mean Vo_2-max with smoking and exercise habit and waist-hip ratio in binary groups were performed by ANOVA and *t*-test respectively. Maximal aerobic capacity in farmers was estimated 2/860/47± litres per minute. The results revealed that aerobic capacity has a significant relationship with age, weight, height, BMI, waist-hip ratio of workers. Statistical tests showed that there is a significant correlation between Vo_2-max and smoking ($P < 0/05$). The mean aerobic capacity in athletes was also lower than non-athletes. Results of this study focus on the significance of demographic features. Factors as age, weight, height, BMI, waist-hip ratio, smoking are considered as effective factors on Vo_2-max in workers and giving attention to them is important in preserving and conserving the health of workers.

Key words: Maximal aerobic capacity, farmers, Tuxworth and Shahnavaz step test.

Introduction

As the societies develop, the need for heavy duty decreases largely; however in many societies some jobs are categorized as heavy duty yet. Activity in various jobs is associated with physical attempt and therefore high energy consumption and creates pressure on cardiovascular and respiratory system. Individuals with high cardiovascular and respiratory endurance and aerobic power can resist more time against muscular work and fatigue (Choobineh et al., 2011).

Maximal aerobic capacity "Vo_2-max": the greatest amount of oxygen (in litre) which can be absorbed by respiratory system in unit of time (one minute) and blood carries it through the body. It is representative of physical work capacity (PWC). PWC is defined as maximal energy value used by individual in 8-hour round without suffering from physiologic stress and

*Corresponding Author

physical fatigue in long time. For this reason, measuring maximal aerobic capacity and determining effective factors on that is of particular importance in physiologic adaptation of worker to work (Khaldan, 1990).

Vo_2-max is different in various people and depends on multiple factors like environmental, psychological and physical factors and physiologic features. When age increases Vo_2-max decreases and its highest value has been observed in 18-25. This capacity in women is lower than men (Eramaki, 1992).

In a study performed in Poland in 2005, Vo_2-max for women and men were achieved 2/1 and 2/82 litres per minute respectively (Wilson et al., 2005). In another study performed in Bengal in 2002 among three groups exposed to dust particles of plant origin, grinding workers rather than agricultural and mill workers had lower Vo_2-max values (Byars et al., 2006).

In a study conducted on male workers of Semnan rolling pipe factory in Iran (1392), the average Vo_2-max in workers was 2/88±0/33 and the average of their physical work was 4/67±0/54 kg per minute (Choobineh et al., 2011). In a study conducted by Ahmad Ebrahimi Atri and others on 30 selected players of volleyball team of Ferdowsi University of Mashhad there was no correlation between Vo_2-max with body composition and BMI (Ebrahimi Atri et al., 2011). A study by Alireza Choobineh and his colleagues conducted on 184 male workers of industry in Sepidan city, average aerobic capacity in workers were achieved 2/66±0/35 litres per minute (Daneshmandi et al., 2013).

To date, most studies about maximal aerobic capacity have been conducted on athletes and industry workers and in our country, few studies have also been conducted in the field but so far no study has been done about aerobic power in agriculture. Therefore, we decided to perform a study on the effective factors on maximal aerobic capacity of male farmers.

Materials and Methods

Studied Population and Sample Selection

This cross-sectional study was conducted from April 2016 to September 2017 and total number of 5000 male farmers of Sistan Region province comprised population of the study.

By using formula $n = z^2s^2/d^2$ a sample size of 400 subjects in confidence level of 95% was determined. These subjects with simple random sampling and by drawing lots from the list of family files in health care houses were selected. After determining samples, workers were invited to healthcare houses and were studied. If any of the selected workers were excluded from the list for any reason (absence, disinclination to take part in the study, cardiovascular diseases), next person would be replaced in the list.

Data Collection Tools

1. Data was collected using demographic questionnaire and through interview with participants. Questionnaire comprised two parts, in first part questions about age, work experience, marital status, level of education, having specific disease, taking any drug and exercise were provided and in second part variables of height, weight, body mass index (BMI) and pulse rate were recorded.
2. Measurement height, weight and calculation BMI: Height and weight of workers with uniform and without shoes, hard hat and gloves were measured. Height is measured by stadio meters in health houses and recorded in the questionnaire. For measuring weight, the worker stood on analogue balance and his weight written down in the questionnaire. To calculate body mass index (BMI) following formula was used. In this formula weight and height are in kilogram and metre respectively.
   $Height^2/weight = BMI$ (WHO Report, 2015).
3. Measurement of maximal aerobic capacity (Tuxworth et al., 1977) (Vo_2-max): Maximal aerobic capacity was measured using Tuxworth and Shahnavaz method. A worker went up and down a 40 cm step with rate of 25 steps per minute; he, then, sat back and after 30 seconds his pulse in seconds (30-60), (90-120), (150-180) was measured. Then, index *b* was calculated using following formula:
   Index *b* = number of pulse in seconds (30-60) + (90-120) + (150-180)/weight
   Then, using equation
   $Y = -0/378\ b + 4/67$,
   Vo_2-max was calculated (Inoue et al., 1996). After estimating Vo_2-max, using following formula, maximal physical work capacity (kcal/min) and then through that PWC were calculated (Ho Bi, 1984).
   Maximal physical work capacity = (Vo_2-max) × 5
   Number 5 is approximate calorific value of one litre oxygen consumed in the body which indicates that burning one litre oxygen in body produces 5 kcal heat (Kline et al., 1987).
   PWC (kcal/min) = (kcal/min) maximal physical work capacity × 33%

Plan Implementation Methods

After selecting workers from family files and providing explanation about test process for every sample, they signed a consent form and announced their readiness to participate in the test. After completing questionnaire by the author and ensuring the absence of respiratory and cardiovascular diseases in worker, the author began to measure height and weight of workers and then Tuxworth and Shahnavaz test was conducted. It should be mentioned that tests were performed in health houses. To determine atmospheric condition of test site, temperature and weather conditions in terms of dust and storm were recorded in the questionnaire.

Statistical Methods

To study the correlation between Vo_2-max and quantitative variables as height, weight and correlation between quantitative variable age and BMI, simple linear regression analyses and ANOVA test were used respectively. T-test was used to compare Vo_2-max with smoking and exercising and waist-hip ratio. P value less than 0/05 is assumed as significant level. Data were analyzed using SPSS software.

Problems and Limitations

Researchers face some limitations and problems in all stages of the study. These include difficulty of commuting between health houses due to long distance and inviting farmers and removal of some workers from sample size because of failure to complete trial and error in computing pulse and stormy weather and interrupting the test.

Result and Discussion

According to the results achieved from Table 3 it can be observed that mean and standard deviation of the highest aerobic capacity in respondents were 2/86±0/47 (litre per minute) and minimum value of highest aerobic capacity and its maximum were 1/22 and 3/79 (litre per minute) respectively. Mean and standard deviation of the highest aerobic capacity in (minute/kg/ml) were achieved 44/47 ±7/47 and minimum and maximum value of the highest aerobic capacity in above unit were estimated 23/92 and 63/12. It is noteworthy also that mean and standard deviation of maximal physical work capacity among participants in the study were estimated 14/28±2/39 (kc per minute) in which minimum and maximum value of this parameter are 6/1 and 18/95 (kc per minute) respectively. It is also noteworthy to mention that mean and standard deviation of PWC in individuals under study were estimated 4/71±0/79 (kc per minute). Minimum and maximum PWC in workers under study were also 2/01 and 6/25 (kc per minute).

Table 1: Mean, standard deviation, minimum and maximum value of some demographic features of individuals under study

Variable	*Max*	*Min*	*SD*	*Mean*
Age	88	26	10/56	51/26
Weight	96	45	8/34	64/89
Height	1/85	1/49	0/05	1/68
BMI	33	15/5	2/62	22/85
Work-experience	70	1	8/96	24/96

Table 2: Frequency distribution of some demographic features and working conditions of workers

Variable		*Frequency percentage*	*Frequency*
Marital status	Single	%2/8	11
	Married	%97/2	389
Education	Illiterate	%69	376
	Elementary	%20	87
	Secondary	%7/2	29
	High school	%1/8	7
	Upper than high school	%2	1
Smoking	Yes	%11/2	45
	No	%88/8	355
Exercise habit	Yes	%16	63
	No	%84	337

Table 3: Mean, standard deviation, minimum and maximal aerobic capacity and maximal physical work in workers under study

Parameter	*Mean*	*SD*	*Min*	*Max*
Highest aerobic capacity (lit/min)	2/86	0/47	1/22	3/79
Highest aerobic capacity (ml/kg/min)	44/47	7/47	23/92	63/12
Maximal physical work (kcal/min)	14/28	2/39	6/1	18/95
PWC (kcal/min)	4/71	0/79	2/01	6/25

The results of ANOVA test reveal that there is a significant relationship between the highest aerobic capacity in workers under study and age and BMI.

In Table 6 mean and standard deviation of the highest aerobic capacity in workers under study have been provided in terms of exercise habit and smoking. Statistical tests showed that there was a significant correlation between smoking and highest aerobic

Table 4: Mean and standard deviation, minimum and maximum value of highest aerobic capacity in terms of age groups

Highest aerobic capacity (L/kg/min)			*Highest aerobic capacity (L/MIN)*			*Age categorization*
Max	Min	Mean±sd	Max	Min	Mean±sd	
63/12	37/53	51/75±6/31	3/79	2/63	3/3±0/23	Less than 40
62/67	23/92	45/17±5/98	3/79	1/22	2/9±0/37	40-60
51/19	29/82	35/17±4/49	3/25	1/53	2/27±0/39	More than 60

Table 5: Mean and standard deviation, minimum and maximum value of highest aerobic capacity in terms of body mass index

Highest aerobic capacity (l/kg/min)			*Highest aerobic capacity (l/min)*			*Categorization of BMI*
Max	Min	Mean± sd	Max	Min	Mean± sd	
63/12	31/96	48/49±1/27	3/10	1/55	2/43±0/64	<18/5
62/69	23/92	45/75±6/78	3/62	1/22	2/88±0/45	18/5-24/9
51/29	30/78	38/87±5/50	3/79	1/92	2/89±0/45	25-29/9
46/22	31/30	38/25±5/52	3/79	2/85	3/38±0/41	>30

Table 6: Mean and standard deviation of the highest aerobic capacity in workers under study in terms of exercise habit and smoking

Significance level	*Sd*	*Mean*	*Number*	*Status*		*Variable*
0/007	0/53	2/72	63	Exercise habit	Exercising status	Highest aerobic capacity
0/016	0/45	2/89	337	No exercise habit		
0/001	0/52	2/64	45	Smoking habit	Smoking habit status	
0/005	0/45	2/89	355	No smoking habit		

capacity so that Vo_2-max was more in health individuals rather than addicts. Since 377 of subjects didn't exercise it is less in athletes.

Table 7 shows that the highest aerobic capacity has a significant relationship with waist-hip ratio in workers under study.

Results of linear regression analyses reveal that with increase in height there is an increase in Vo_2-max:

$$Y = 2/85\ X + 0/358 \quad (1)$$

Then, using linear regression analyses it was found that there is a significant positive linear correlation in a form of 3-2 equation between highest aerobic capacity and workers' weight.

$$Y = 0/022\ X + 0/396 \quad (2)$$

Mean and standard deviation of Vo_2-max was achieved in litre per minute (2/86±0/47). Mean and standard deviation of maximal physical work capacity was achieved in kc per minute (14/28±2/29) which value was slightly more than mean Vo_2-max in male population of Sepidan factory in the study by Choobienh et al. (2/66±0/35) in litre per minute and less than mean achieved in the study by Hosein Abadi over aerobic capacity of men in the galvanized part of Semnan rolling pipe company (2/88±0/33). In the study by Sedigheh Hosein Abadi in Semnan rolling pipe company, mean and standard deviation of Vo_2-max was obtained in LIT/min which result is slightly more than mean achieved in the study by Choobineh et al. (2016).

Results of this study revealed that there is a significant correlation between Vo_2-max and workers' age under study. In this research 69% of individuals were categorized in the age group 40-60 years and workers younger than 40 years had the most mean aerobic capacity (33/3±0/23 litre per minute) and workers older than 60 years had the least mean Vo_2-max (2/27±0/39 litre per minute) which represents that Vo_2-max decreases considerably in increasing age.

Table 7: Mean and standard deviation, minimum and maximum value of highest aerobic capacity in terms of waist-hip ratio

Highest aerobic capacity (ml/kg/min)			*Highest aerobic capacity (l/min)*			*Waist-hip ratio*
Maximum	Minimum	Mean±sd	Maximum	Minimum	Mean±sd	
63/12	23/92	44/37±7/56	3/79	1/22	2/84±0/47	Less than 0/95
57/25	31/96	45/47±6/62	3/67	1/63	3/06	More than0/95

Table 8: Correlation between the highest aerobic capacity and height/weight of subjects.

Significance level	*df*	*r*	*t*	*b*	*beta*	*Mean±standard deviation*	*Parameter variable*
0/001	1	0/128	7/65	2/85	0/358	1/68±0/05	Height
						2/86±0/47	Vo_2-max
0/001	1	0/396	8/608	0/002	0/396	64/89±8/34	Weight
						2/86±0/47	Vo_2-max

Age group between 18-25 years have the most aerobic capacity.

This finding doesn't match with findings obtained from the study by Choobineh with age mean (31/85±7/85). In some other studies, of course, as study by Buga Jessica et al. (2011) it has been shown that aerobic capacity decreases in increasing age which finding matches with the results of present study.

Different opinions about relationship between Vo_2-max and age may be referred to studied population in terms of weather conditions (Amarathunga et al., 2017), life style, eating habits and race. Moreover, Vo_2-max has a significant relationship with age and physical condition. Other studies suggest that males have higher Vo_2-max compared to females.

In the study of relationship between Vo_2-max and weight and height, regression analyses showed a significant linear correlation between these variables and Vo_2-max. This means that with increase in weight and height, there is an increase in aerobic capacity. Results from past studies confirm findings of this research (Razzaghi Bokhani et al., 2018).

The results of the current study specified that there is a significant correlation between Vo_2-max and smoking ($p < 0/05$), so that mean Vo_2-max in people who smoke (2/64±0/52) is significantly less than in one who don't smoke (2/89± 0/45). This finding matches with the results from studies by Choobineh and Sedigheh Hosein Abadi et al. Study by Hosein Abadi is different from study by Choobineh in few number of people who smoke and 60% were athlete. One of the reasons for this decrease is that blood is saturated with carbon monoxide in cigarette and subsequently oxygen-carrying capacity is decreased by blood.

The results from this research suggested that the mean aerobic capacity in athletes (2/71±0/52 litre per minute) is less than one in non-athletes (2/89±0/45) because 337 people of participants in above study didn't exercise and other factors have also considerable impact on maximal aerobic capacity which this finding doesn't match with results from the study by Choobineh et al. in their study mean aerobic capacity in athletes is significantly more than one in non-athletes. This refers to the role of exercise in improving physiologic function and aerobic capacity which has been confirmed in other studies (Chaterjee et al., 1994).

In the study by Sedigheh Hosein Abadai et al. there was not any significant relationship between aerobic capacity of athletes and non-athletes. The difference in the study by Hosein Abadai and study by Choobineh et al. About the relationship between Vo_2-max and exercise may be due to irregular exercise programme in participants. Also, results from this study showed that there is a significant relationship between highest aerobic capacity and waist-hip ratio ($p < 0/05$) and it is more in people with waist circumference of more than 0/95. This finding had not been considered in previous studies.

Results from this study suggested that about three-quarter of farmers have BMI (24/9-18/5). The highest mean value of aerobic capacity was seen in individuals with BMI more than 30 who were categorized in obese group (3/38±0/41). The lowest mean value of Vo_2-max was estimated in people with BMI less than 18/5 (2/43±0/64 litre per minute) (Betik et al., 2008).

As a result, there is a significant relationship between the most aerobic capacity and BMI which also matches with the results from Choobineh et al. and Sedigheh Hosein Abaadi. Aerobic capacity is less associated with mental parameters and more influenced by physical features especially body mass index of individuals. Study by Atri states that volleyball is a

sport which needs high anaerobic power and remarkable anthropometric and physiologic features like tall player, low BMI, low body fat percentage.

Conclusions

1. Agriculture is assumed as a heavy activity and requires high aerobic capacity.
2. To date, most studies throughout the world about maximal aerobic capacity have been conducted on athletes and industry workers and studies on agriculture are confined.
3. In our country few studies have also been performed on the sport and industry sector. The results of this research can provide information about mentioned parameters in agriculture.
4. Results of this study revealed that there is a significant relationship between Vo_2-max and age, weight, height, BMI, waist-hip ratio, exercise and smoking and above variables are effective factors on aerobic capacity of workers.
5. Therefore, it could be concluded that Vo_2-max is mostly influenced by physical parameters.

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