

Role of a 15- week Aerobic Exercising Program in Promoting Cardiovascular Fitness among Flight Personnel

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Abstract

Aims: The aim of this study was to determine the effectiveness of aerobic exercises in the promotion of cardiovascular fitness in flight employees.

Methods: In this randomized controlled trial, 30 flight personnel from Mehrabad and Imam Khomeini Airports in Tehran, Iran were selected and randomly assigned to the treatment and control groups (15 in each). Cardiovascular fitness was evaluated by measuring VO₂max (using Step Test) and resting heart rate (RHR). A 15 week aerobic exercising program was given to the treatment group. As placebo, the participants in the control group were advised to do stretching exercise. Then cardiovascular fitness was assessed again. Obtained data were analyzed using relevant statistical methods.

Results: The mean VO₂max and RHR were not significantly different between the two groups at the pretest. Performing a 15-week exercise protocol, the treatment group had a significantly higher VO₂max and lower RHR, but the control groups did not show any change. There was no significant difference in BMI before and after trial.

Conclusion: Appropriate aerobic exercising protocols can result in the promotion of cardiovascular fitness and aerobic capacity in flight personnel if they are designed properly and performed regularly for a long time.

Keywords: Body Mass Index, Flight Personnel, Cardiovascular Fitness, Aerobic Exercises, VO₂max, Resting Heart Rate

Introduction

An individual's Aerobic Capacity is the maximum oxygen or energy he or she consumes in a short time. 33% of this capacity constitutes his working capacity or ability for 8 hours of daily activities [1]. The higher one's aerobic capacity is, the higher his capacity for doing physical activities will be. This means that he or she can do heavier and more energy-consuming activities. As such, this index is a good one to determine one's ability for doing physical activities [2]. Gathering information regarding individuals' aerobic capacity is very important because having a good estimation of an individual's capacity for doing physical activities can be very helpful in planning aviation and military missions especially when it comes to the estimation of military and aviation personnel's threshold for physical activities or cargo carriage [2]. Previous studies indicate that regular exercising has an important role in the improvement of cardiovascular fitness, and giving-up such an activity will result in the disappearance of such benefits [1-4].

The most common index used for demonstrating the effect of exercising on individuals' aerobic capacity is the maximum amount of oxygen used ($VO_2\text{max}$). *Braga et al.* [5], having studied firefighters, observed that the gradually increasing exercises on treadmill could help increase $VO_2\text{max}$ and participants' aerobic capacity. Moreover, *Dyrstad's* study showed that military training could increase the $VO_2\text{max}$ by 3 percent in Norwegian infantry soldiers [6]. Another study showed that a 14 week swimming program could considerably increase the $VO_2\text{max}$ in girls [7]. What is important about

the above-mentioned studies is that the effect of a variety of exercises was studied on a variety of participants, and all showed their effectiveness in increasing $VO_2\text{max}$.

Another variable usually examined in the studies on the effect of aerobic exercises is Body Mass Index (BMI). Though many studies showed the effectiveness of exercising on BMI [8], some other reported the lack of such an effect [8, 9].

Physical and dynamic fitness has always been one of the major concerns for flight crew. It is also one of the factors determining their efficacy. The building blocks of physical and dynamic fitness include the capability of doing an action consecutively, the ability to return to normal state after the exercise, willingness to do the assigned tasks, developing skills, and having self-confidence in facing any situation [10].

Due to the important role of one's aerobic capacity in doing physical activities and since $VO_2\text{max}$ is assessed in relation to other factors (such as cardiac output, lung ventilation, CO_2 and oxygen transfer, and physical and muscular fitness), the identification and assessment of individuals' aerobic capacity is of utmost significance [11].

From occupational medicine point of view, aviation-related jobs are among jobs for which individuals' health condition and check-ups play an active role in the selection of personnel. Such personnel have particular patterns for their workplace, time, and conditions which can cause them not only job-related disorders but also problems for their nutritional program, sleep, stress management, and physical activities [12-14]. All these will affect their job efficacy [15-

17]. The present study was an attempt to examine the effect of aerobic exercises on improving the cardiovascular fitness in flight personnel.

Methods

In the present study the male personnel of the Mehrabad and Imam Khomeini international airports took part. The population consisted of 297 employees out of whom 30 employees were randomly selected for the purpose of the study. In order for an employee to be chosen, his age should have been between 20 and 45, and he should have had at least 2 years of related experience. A selected participant could be left out of the study due to any one of the following reasons: lack of consent for participation, any medical disease, smoking background, surgical operation in the past 3 months, BMI above 25, having any anatomic, biomechanical, pathological problem in his skeletal-muscular system, a background of heart disease in him or his family, any doubt about his suffering from any kind of cardiovascular and skeletal-muscular disease, high blood pressure (above 120/80) before the test, having fever at the time of test (oral temperature above 37 °C), and any sign of abnormal heart activity in the cardiogram. The 30 randomly selected participants were randomly assigned to control (15 participants) and treatment (15 participants) groups. A written participation consent form was collected from each participant before the study began. Then participants were examined physically, and their medical records were checked. Their height, weight, BMI, resting heart rate (RHR), and cardiogram were checked too. Their before-intervention $VO_2\max$ was estimated, and a 15 week aerobic exercise program was given to the treatment group while the control group received a program for doing stretching exercises as placebo. Participants' heart rate while exercising and resting was recorded using Polar heart rate monitor. The sensors

on participants' chest sent the impulses to a special wrist watch, and the heart rates were automatically recorded in a special form.

In order to estimate $VO_2\max$, step tests using McArdle or Queen's College methods were performed, and the results were recorded [18-20]. All the information regarding participants' height, weight, BMI, RHR, maximum heart rate and $VO_2\max$ were recorded in special forms prior to the intervention.

The treatment group started the aerobic exercises at a predefined time and date and had it in their daily schedule for 15 weeks. The program had four stages: 1) body warm-up, 2) aerobic exercises in the form of jogging, 3) doing some mild exercises in the upper and lower part of body, 4) some very mild exercises to return to the initial state of body. The exercises were done 3 times a week starting with 15 minutes on the first session. Each session one minute was added to exercising time so that at the end of week 15, the exercising time had reached 60 minutes. The control group was advised to do stretching exercises for 15 minutes 3 times a week.

After each 800 meters, the treatment group's pulse rates (after being consistent) were checked by participants themselves. The maximum heart rate was estimated using *Karvonen's* [6] formula (maximum heart rate = $220 - \text{age in year}$). After the intervention, participants' $VO_2\max$ and BMI were checked as in the pretest. The obtained data were analyzed using both parametric and non-parametric tests according to the nature of data.

Results

Participants' age ranged from 23 to 37, and the minimum and maximum BMI were 20.37 and 24.78 respectively. There was no significant difference between the two groups' age and BMI. Table 1 summarizes the descriptive statistics for the two groups

prior to the intervention. The difference between treatment and control groups in RHR and VO₂max was not statistically significant prior to the intervention ($p = 0.91$ and $p = 0.69$ respectively).

Assessing after Intervention: After the intervention, neither the treatment group nor the control group did have a statistically significant change in their BMI. There was also no statistically significant difference between the two groups in their BMI after the intervention ($p = .053$).

No significant change was observed in the control group's VO₂max and RHR from pretest to posttest ($p = 0.37$ and $p = 0.81$ respectively). However, in the case of treatment group, VO₂max had a significant raise from pretest to posttest ($p = 0.000$) and RHR showed a statistically significant decline ($p = 0.000$). The comparison between the two groups in the posttest showed a significantly higher VO₂max ($p = 0.049$) and a significantly lower RHR ($p = 0.001$) for the treatment group.

Table 1. Descriptive Statistics for the 2 Groups at Pretest

Demographical Variables	Treatment Group		Control Group		Sig.
	Mean	Std. Deviation	Mean	S.D	
Age(year)	29/5	3/57	31/6	3/97	0/72
Height(cm)	177	5/68	180	5	0/31
Weight(kg)	77/5	4/99	76/8	7/46	0/43
BMI	24/75	1/44	23/78	2/97	0/05

Table 2. VO₂max & PHR before & after the Intervention

Variables	Time	Frequency	Control Group		Sig.	Treatment Group		Sig.
			Mean	Std. Deviation		Mean	S.D	
PHR	Pre test	15	83/80	1/32	0/806	83/40	3/49	0/000
	Post test	15	83/73	1/43		73/73	2/37	
Vo2max (cc/kg/min)	Pre test	15	33/97	1/00	0/37	34/60	0/95	0/000

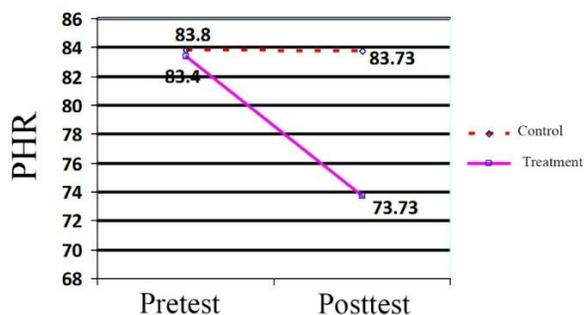


Figure 1. RHP change for the 2 Groups before & after the Intervention

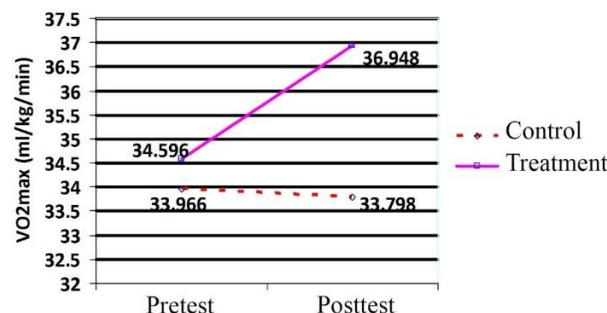


Figure 2. VO₂max Change of the 2 Groups before & after the intervention

Discussion

The results of the study showed that a 15 week aerobic exercising program can increase flight personnel's $VO_2\text{max}$ and lower RHR, but it cannot change their BMI. The obtained results on BMI change in this study are in contrast with those obtained by *Johns* and *Mahoneni* in 1997, *Halle* and *Berg* in 1999, *Dolatabadi* in 2000, *Thong* in 2000, *Berki* et al. in 2004, *Ozcelik* et al. in 2005, *Zigmon* et al. in 2006, and *Zoo* in 2007 [8,9, 21-23]. BMI significantly decreased in those studies.

Losing weight is a decrease in body fat rather than the mass without fat. Therefore, a good combination of nutritional dieting and regular exercising can be very helpful in controlling BMI. Increasing physical activities and lowering the received calories is a reasonable approach for preventing from losing body mass without fat. In fact, human body structure changes considerably as the result of physical activities. Long time exercising programs can help increase no-fat body mass and decrease the fat in body. Exercising, if combined with a moderate diet, can increase no-fat body mass [23]. Since the length of intervention and participants' diet vary across studies, coming up with different results regarding the effect of exercising on BMI seems natural. The participants in the present study were not overweight, which can be a possible reason for observing no decrease in BMI.

Regarding the increase in $VO_2\text{max}$ for the treatment group, our findings are in line with those in *Hickey* et al. [26], *Houmard* and *Cox* [27], and *Elias* et al. [25]. However, in some other studies like the one by *Zhagner* [24] such an increase was not observed. It seems that aerobic exercises increase the number of muscular capillaries, which help better blood circulation. The number and size of the skeletal-muscular mitochondria may also increase as a result of aerobic exercises. This will improve metabolism, which will result in

an increase in the aerobic capacity of muscles [24-27]. The differences in the findings of previous studies could be attributed to the differences in participants' dieting, type and length of exercising as well as individual differences.

In the study done by *Duey* et al [28], after 6 weeks of endurance training at an intensity of 60 to 70 percent of participants' aerobic capacity, RHR showed no significant change while their aerobic capacity had a statistically significant increase (almost 18%). On the other hand, *Billat* et al. concluded that a moderate 4 week aerobic exercising program can result in a significant decrease in RHR but cannot increase aerobic capacity [29].

Regarding the length of exercising, *Katayama* et al. mentioned that 8 weeks of aerobic exercising can significantly lower RHR [30] while *Weir* et al. [31], having their participants do aerobic exercises at 80% of their maximum aerobic capacity for 8 weeks, reported no significant change in aerobic capacity.

Other researchers have reported a considerable raise in $VO_2\text{max}$ after 10 weeks of military exercises [6, 32]. In 2006, *Sideravi* et al. [7] examined the effect of long term swimming on the aerobic capacity of healthy girls and girls with diabetes. They observed that after 14 weeks of swimming, the aerobic capacity improved for both groups. Some researchers believe in a longer period of exercising for increasing aerobic capacity [33, 34]. *Akimoto* et al. found that 12 months of moderate exercising could significantly increase $VO_2\text{max}$ [33]. The literature points out that the length and intensity of aerobic exercises has a considerable effect on individuals' RHR and aerobic capacity. As observed above, the differences in the length and intensity of aerobic exercises have resulted in different and sometimes contradictory results regarding the change in RHR and $VO_2\text{max}$.

Unlike other studies in which the length and intensity of the exercise is fixed and exercising is in the form of pedaling only [28-30], in the present study, due to the gradual increase in the time and intensity of exercises, participants' body could adapt itself with the aerobic exercises over 15 weeks which is a long period of time. As such, the differences between the findings of this study and other studies is due to differences in the procedure.

Despite the consensus among researchers on the beneficial effect of exercising, the most effective program for eliminating inactiveness has not been proposed yet. Still, scholars disagree on the length and intensity of aerobic exercises. Some believe that 6 weeks (3 times a week for 20 minutes each time) of endurance exercising at one's 60 to 70 percent of VO_2max can significantly decrease RHR for healthy and inactive people, but it cannot increase VO_2max [28]. Some other scholars believe that 4 weeks of aerobic exercises (once a week for a short time) at 50 percent of one's VO_2max is enough for decreasing RHR [29]. Still another study showed that 8 weeks of aerobic exercising (5 times a week for 30 minutes each time) at participants' 85 percent of VO_2max could not increase their VO_2max [31] while *Katayama et al.* [30] found the opposite.

Most scholars believe that one can improve his or her VO_2max by 15 to 20 percent on average [35]. Aerobic exercises can have different short-term and long-term physiological effects on one's heart and VO_2max . Doing aerobic exercises for one session can increase ejection fraction and cardiac output, but in the long run, it can decrease RHR and subsequently the heart rate in a physical activity. It can also increase one's VO_2max in the long run. In other words, heart will be able to pump the needed blood in fewer beats [36]. Moreover, a

decrease in the number of heart beat will increase the diastolic time and will consequently improve blood circulation in cardiac muscles [36, 37].

The participants taking part in the present study had a VO_2max level of 33.97 in the control group and 34.60 in the treatment group with a mean age of 29.5 and 31.6 respectively. These statistics are low according to standards [38-40]. This can indicate that the present exercising programs in the studied organization are not efficient enough, and a better and regular exercising program is necessary.

In studies done in occupational medicine, Healthy Worker Effect is an important element. According to this theory, usually those who are employed in some occupations like aviation must enjoy a high level of physical fitness. Though the initial VO_2max was low for these employees, their responsiveness to the program indicated that they are in a good physical condition.

The generalization of the findings of this study should be done with great care. One limitation contaminating the results is that the contact between the members of the two groups with each other and their information exchange was inevitable. Moreover, in case a treadmill or an ergometer was used, the estimation of VO_2max could be more precise.

Conclusion

It seems that without having an acceptable level of physical fitness on the part of flight personnel, their success in their assigned tasks and responsibilities is not possible. As such it seems necessary to screen the job applicants for their physical fitness before recruitment. Also, organizations need to have planned and designed exercising programs for their personnel by considering the important elements of length and intensity of the exercises in order to increase VO_2max and lower RHR.

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