Comparison Of The Acute Response Of Morning And Evening OutdoorExercise To Oxygen Saturation (SpO_2) After Aerobic Activity

Rakhmat Nur Hidayat[a], Gadis Meinar Sari[ab], Damayanti Tinduh[c]

Corresponding Author: Gadis Meinar Sari, E-mail: gadis-m-s@fk.unair.ac.id

[a.]Sport Health Science, Faculty of Madicine, Universitas Airlangga, Surabaya, Indonesia
[b.]Department of Physiology and Medical Biochemistry, Faculty of Medicine Universitas Airlangga, Surabaya, Indonesia
[c.]Department of Physical Medicine and Rehabilitation, Faculty of Medicine Universitas Airlangga, Dr. Soetomo General Academic Hospital, Surabaya, Indonesia

Abstract

The condition of O_2 in the morning is different from the night because the process of photosynthesis occurs in plants. Plants absorb CO_2 in the morning and release CO_2 at night. Exercise affects the frequency of breathing which results in an increase in the mass of accessory muscles of respiration so that the uptake of O_2 in the lungs increases. O_2 is taken up by the blood through the lungs and binds to Hb. O_2 that diffuses into the lungs and binds to Hb, affects the value of the body's oxygen saturation (SpO_2). This study aims to compare the acute response of morning and evening outdoor exercise to oxygen saturation (SpO_2) after aerobic activity. This type of research is a quasi-experimental pretest-posttest with a cross-over design. The subjects were 32 athletes who were divided into 2 groups. Measurement of oxygen saturation using a pulse oximeter. The data analysis technique used the statistical package for social science (SPSS 16.0). The results of the oxygen saturation analysis before morning and evening outdoor exercise showed no significant difference ($p>0.05$). Oxygen saturation after morning and evening outdoor exercise showed no significant difference ($p>0.05$). The results of this study concluded that there is no difference in oxygen saturation before outdoor exercise in the morning and evening. There is no difference in oxygen saturation after morning and evening outdoor exercise.

Keywords: Oxygen saturation, morning outdoor exercise, evening outdoor exercise, aerobic activity

Introduction

Exercise is an important activity in life because it can improve and maintain health. The body becomes fit and avoids obesity, diabetes, and cardiovascular disease. Exercise is generally done in the morning, but some people choose to exercise at night because of the hectic work activities. Exercise can be done in indoor or outdoor environmental conditions. The acute response of exercise to outdoor environmental conditions in the morning and outdoor at night has not been widely studied. The condition of oxygen (O_2) at night is different from the morning because of the photosynthesis process in plants, plants absorb CO_2 in the morning and release CO_2 at night[(4)]. Night exercise increases the hormone adrenaline which has an impact on increasing heart rate and body temperature.

The condition of oxygen at night is different from the morning, so it affects hemoglobin in binding oxygen when doing physical activities at night. The morning oxygen pressure is higher, so the ability of hemoglobin to bind oxygen increases, the oxygen pressure at night is lower so that the ability of hemoglobin to bind oxygen decreases. CO_2 morning and evening that there is a significant change. The research was conducted in indoor conditions. This condition contains more CO_2 gas at

night and affects the human respiratory system because someone who does night exercise activities will get less O_2[9].

Aerobic activity is an activity that depends on the availability of oxygen (O_2) in the process of burning energy sources[7]. The aerobic energy system takes place after the process of fulfilling the ATP-PC (adenosine triphosphate phosphocreatine) energy for about 120 seconds, then after the process is needed oxygen (O_2) to help the process of resynthesis of lactic acid into a source of energy again[10]. When the body performs exercise activities, aerobic and anaerobic metabolic processes occur in the body[14].

Oxygen saturation (SpO_2) is the percentage of hemoglobin bound to oxygen in the arteries because most of the O_2 in the blood is transported bound to hemoglobin[9]. O_2 is taken up by the blood through the lungs and binds to hemoglobin[11]. The more O_2 diffuses into the lungs and binds to hemoglobin, the value of SpO_2 in a normal person's body ranges from 95-100%[9]. Comparison SpO_2 people living on the coast and in the mountains, it is known that the value of SpO_2 people living in the lowlands is higher than people living in the highlands [5]. Found that there was no significant difference before and after doing acute exercise, sprinting at a distance of 200 meters[9].

Based on the above background, the researcher wanted to prove a comparison of the acute response of morning and evening outdoor exercise to oxygen saturation after aerobic activity. This research was conducted on Situbondo Futsal athletes.

Methods

This research is a quasi-experimental pretest-posttest with a cross-over design. A total of 32 athletes in the 17-21 year age category. Subjects who initially received the morning outdoor treatment and after a predetermined period of time would cross over to the night outdoor treatment and vice versa, subjects who initially received the evening outdoor treatment would cross over to receive the morning outdoor treatment. The researcher gave a wash-out period of 2 days. The research population is the athletes of the Kab. Situbondo. The sample was divided into 2 groups, namely K_1 (group 1, n=16) and K_2 (group 2, n=16). The research was conducted at the Zakunar Football Field, Kab. Situbondo within ±5 days.

Outdoor exercise in the form of jogging with a total time of 60 minutes which is divided into 15 minutes of warming up and 45 minutes of jogging. The intensity of outdoor exercise is ±50%-60%. Morning outdoor exercise are held at 07:00 WIB and evening outdoor exercise are carried out at 19:00 WIB. Data collection of oxygen saturation (SpO_2) with a pulse oximeter, aims to measure oxygen levels in the blood. Data collection was carried out before and after outdoor exercise. The research procedure has been approved by the health research ethics committee, faculty of medicine, airlangga university, surabaya, indonesia, number 279/EC/KEPK/FKUA/2021.

Statistical analysis using SPSS version 16. Normality test using the Shapiro-Wilk test with a significant level ($p>0.05$). The difference test of influence uses paired sample t-test and the different comparison test uses the independent sample t-test with a significant level ($p<0.05$). All data are displayed with mean±standard deviation (SD).

Result

The results of the descriptive test, normality test, different effect test, and comparison test of research subjects are presented in table 1 below.

Table 1. Characteristics descriptive test results

Parametric	Group	N	Mean±sd	Shapiro-Wilk	Independent t-test
Age	K_1	16	18.75±1.29	0.149	0.690
	K_2	16	18.93±1.34	0.158	
TB(cm)	K_1	16	166.56±5.59	0.075	0.755
	K_2	16	167.12±4.17	0.681	
Body Weight (kg)	K_1	16	60.23±6.32	0.315	0.542
	K_2	16	61.52±5.51	0.996	
BMI (kg/m^2)	K_1	16	21.53±1.47	0.187	0.619
	K_2	16	21.81±1.68	0.738	

Description: K_1: group 1; K_2: group 2; TB: height; BB: body weight; BMI: body mass index. All data displayed with mean ± standard deviation (SD)

Based on table 1, it is known that the average data on the characteristics of the research subjects there is no significant difference. The results of the Shapiro-Wilk test showed that all the data on the characteristics of the research subjects were normal ($p>0.05$). The results of the independent t-test, it is known that there is no significant difference ($p>0.05$). The results of the statistical analysis of oxygen saturation are presented in table 2 below.

Table 2. The results of saturation in the first and second periods

		Outdoor Exercise	N	SpO_2 (%)			Paired T-Test
				Pretest	Δ	Posttest	
P1	**K_1**	Morning	16	96.06±1.34	1.31±0.48	97.37±1.36	0.000
	K_2	Evening	16	95.93±1.06	1.06±0.57	97.00±1.03	0.000
P2	**K_2**	Morning	16	96.37±1.31	1.06±0.44	97.43±1.26	0.000
	K_1	Evening	16	95.87±1.25	1.06±1.00	96.93±1.06	0.000

Description: P_1: first period; P_2: second period; K_1: group 1; K_2: group 2; SpO_2: oxygen saturation (%); percentage. Data is shown mean±standard deviation.

Based on table 2, the mean pretest-posttest SpO_2 for the first and second periods had a significant effect ($p<0.05$). The results of the normality test using the Shapiro-Wilk pretest-posttest SpO_2 for the first and second periods, all data were normally distributed ($p>0.05$). The results of the pretest-posttest SpO_2 difference test for the first and second periods in each group with the paired t-test showed that there was a significant effect ($p<0.05$).

Table 3. The results of the comparison of the percentage of SpO_2 outdoor in the morning and evening

			Outdoor Exercise	N	SpO_2 (%) mean±SD	Independent T Test
P1	**Pretest**	**K_1**	Morning	16	96.06±1.34	0.772
		K_2	Evening	16	95.93±1.06	
	Posttest	**K_1**	Morning	16	97.37±1.36	0.387
		K_2	Evening	16	97.00±1.03	
P2	**Pretest**	**K_2**	Morning	16	96.37±1.31	0.280
		K_1	Evening	16	95.87±1.25	
	Posttest	**K_2**	Morning	16	97.43±1.26	0.235
		K_1	Evening	16	96.93±1.06	

Description: P_1: first period; P_2: second period; K_1: group 1; K_2: group 2; SpO_2: oxygen saturation (%). Data is shown mean ± standard deviation.

Based on table 3, the results of the comparison of SpO_2 pretest-posttest for outdoor exercise in the first and second periods with the independent sample t-test, it is known that there is no significant difference ($p>0.05$).

Discussion

1. Characteristics of research subjects

Based on table 1, it is known that the average value of the characteristics of the research subjects in each group has no significant difference ($p>0.05$). The results of the descriptive analysis of the research subjects showed that the average age of K_1 was 18.75 years and K_2 was 18.93 years. The results of the average height of K_1 is 166.56 cm and K_2 is 167.12 cm. The results of the average weight of K_1 is 60.23 kg and K_2 is 61.52 kg. The average BMI of K_1 is 21.53 kg/m2 and K_2 is 21.83 kg/m2. The results of the Shapiro-Wilk normality test for all the characteristics of the research subjects were normal ($p>0.05$). The results of the different independent sample t-test showed that there was no significant difference in each group ($p>0.05$).

There is a relationship between age and frequency of exercise with SpO_2, but there is no relationship between BMI and pulse rate on SpO_2[(1)]. Because physical ability in the form of aerobic exercise at the age of adolescents-adults increases to a maximum at the age of 25-30 years, then there is a decrease in the functional capacity of the whole body by ±0.8%-1% per year, but exercise can reduce this decrease to halved[(13)]. The respiratory system during exercise will be accompanied by a cardiovascular response in the form of increased lung ventilation to meet blood oxygenation[(1)].

2. Comparison of the acute response of morning and evening outdoor exercise to SpO_2

Based on table 2, the average pretest-posttest SpO_2 of outdoor exercise in the first and second periods had a significant effect ($p<0.05$). Although there is an effect, SpO_2 is still in the normal range of 95%-100%. The mean value of pretest outdoor morning oxygen saturation is 96.06%, the posttest is 97.37%, and the mean pretest-posttest SpO_2 outdoor morning in the first period is 1.31. The mean value of pretest SpO_2 outdoor in the second period was 96.37%, the posttest was 97.43%, and the mean pretest-posttest SpO_2 outdoor in the second period was 1.06. The results of the different pretest-posttest SpO_2 outdoor morning in the first and second periods with the paired t-test, it is known that there is an effect before and after morning outdoor exercise ($p<0.05$). the mean pretest-posttest SpO_2 of night outdoor exercise in the first and second periods had a significant effect ($p<0.05$). The mean value of pretest SpO_2 for night outdoor exercise was

95.93%, the posttest was 97.00%, and the mean pretest-posttest SpO_2 for night outdoor exercise was 1.06. The mean of the pretest SpO_2 value for the second period of night outdoor exercise was 95.87%, the posttest was 96.93%, and the mean pretest-posttest SpO_2 of the second period of outdoor exercise was 1.06. The results of the pretest-posttest SpO_2 test for outdoor exercise for the first and second periods with the paired t-test showed that there was an effect before and after night outdoor exercise on oxygen saturation ($p<0.05$). The results of the comparison analysis of SpO_2 pretest-posttest for outdoor exercise in the first and second periods with independent t-test showed that there was no significant difference ($p>0.05$).

The results in this study indicate that the effect of outdoor exercise in the morning and evening is relatively the same in increasing oxygen saturation (SpO_2). However, the SpO_2 of outdoor exercise in the morning was higher than the SpO_2 of outdoor exercise at night after 60 minutes of aerobic activity. This can be due to better morning air conditions because plants absorb CO_2 so that air circulation in the human respiratory system gets more O_2[4]. Oxygen pressure and blood acidity in the morning are higher, so hemoglobin binding O_2 increases. Oxygen pressure and blood acidity at night are lower, so the ability of hemoglobin to bind oxygen decreases[3]. Environmental factors have an important role in oxygen availability because when O_2 levels are low, pulmonary ventilation increases and causes hemoglobin to increase[2].

Acute aerobic exercise will increase lung perfusion, ventilation, and diffusion rates. This is because the frequency of breathing during exercise increases and breathing becomes deeper so that the air pressure in the lungs will increase and increase the diffusion of O_2 and CO_2. Exercise affects the frequency of breathing which results in an increase in the mass of the accessory muscles of respiration and is in line with the increase in work intensity so that the uptake of O_2 in the lungs increases. This results in increased ventilation and blood flow[9]. Oxygen is taken up by the blood through the lungs and binds to hemoglobin[11]. The more oxygen diffuses into the lungs and binds to hemoglobin, it affects the value of oxygen saturation in the body[9]. The results of this study are in line with several previous studies, aerobic exercise can improve clinical symptoms, recurrence frequency, asthma, oxygen saturation, and peak expiratory flow (APE)[8]. There is an effect of acute physical exercise in the morning on increasing the value of oxygen saturation[11]. Because 4 minutes after starting physical exercise there will be an increase in O_2 uptake by the lungs by 15 times than normal and decreases slowly until 40 minutes after physical exercise. During exercise, there is a 25-fold increase in blood flow[3]. Another study found there was no significant change or the average partial pressure of oxygen before and after night futsal practice remained in the normal category[14].

Conclusions

The results of this study concluded that there is no difference in oxygen saturation before outdoor exercise in the morning and evening. There is no difference in oxygen saturation after morning and evening outdoor exercise.

Further research is needed with a variety of exercise activities such as anaerobic pre-dominant exercise. Subject variations such as basketball, volleyball, badminton athletes can use male or female non-athlete subjects to see changes and comparisons of morning and night outdoor exercise on oxygen saturation.

Conflict of interest – The authors declare that they have no competing interests.

References

1. Damayanti, S. (2016). Studi komparatif kapasitas vital paru dan saturasi oksigen pada atlet futsal dan non atlet di yogyakarta. Jurnal keperawatan respati. Vol.3(2) Hal:23-34 ISSN:2088-8872
2. Deswandi., E., Syampurma, H. (2019). Perbandingan adaptasi lingkungan bagi atlet yang berlatih di daerah dataran tinggi dan dataran rendah terhadap vo_2max dan kadar hemoglobin darah pada olahraga anaerobik. Jurnal menssana. Vol.4 No.2 Hal:156-164 e-ISSN: 2622-4917
3. Ganong, W.F. (2012). Review of medical physiology 24thed. USA: McGraw-Hill companies ISSN 0892-1253
4. Isprayoga, I. (2015). Efektivitas latihan aerobik pagi dan malam hari terhadap kadar hemoglobin dan kadar leukosit (studi eksperimen pada mahasiswi ilmu keolahragaan FIK UNNES). Skripsi: diterbitkan. Semarang: FIK Universitas Negeri Semarang
5. Kaprawi, T., Moningka, M., Rumampuk, J. (2016). Perbandingan saturasi oksigen pada orang yang tinggal di pesisir pantai dan yang tinggal di pegunungan. Jurnal e-Biomedik (eBm).Vol.4 No.1. Hal:11-14
6. Mushab, Hairuddin, & Abrori, C. (2020). Perbandingan peningkatan kadar malondialdehid (mda) serum setelah olahraga pagi dan malam hari pada orang tidak terlatih. Jurnal kesehatan andalas. Vol.9 No.2 Hal:211-217
7. Palar
8. Rita, 2010. Pengaruh Senam Asma Dalam Memperbaiki Gejala Klinis dan Frekuensi Kekambuhan Pada Pasien Asma. Denpasar. Balai Besar Kesehatan Paru Surakarta.
9. Rompas, S.E., Pangkahila, E.A., Polii, H. (2020). Perbandingan saturasi oksigen sebelum dan sesudah melakukan latihan fisik akut pada mahasiswa fakultas kedokteran unsrat angkatan 2019. Jurnal e-Biomedik (eBm).Vol.8(1) Hal:41-45 eISSN 2337-330X
10. Sherwood, L. (2013). Introduction to human physiology, 8th edition. Brooks/Cole, Cengage learning
11. Simanjuntak, R.H., Engka, J.N.A., Marunduh., S.R. (2016). Pengaruh latihan fisik akut terhadap saturasi oksigen pada pemain basket mahasiswa fakultas kedokteran unsrat.Jurnal e-Biomedik (eBm).Vol.4 No.1 Hal:20-24
12. Teo, W., Newton, M.J., & McGuinan, M.R. (2011). Circadian rhythms in exercise performance: Implications for hormonal and muscular adaptation. Journal of exercise science and medicine.Vol.10 Hal:600-606
13. Wicaksono, S.A. (2015). Pengaruh latihan aerobik terhadap peningkatan saturasi oksigen pada pemain bola basket unit bola basket universitas muhammadiyah surakarta. Skripsi. Semarang: Fakultas Ilmu Kesehatan
14. Yunus, N.M. (2020). Perbandingan respon akut olahraga futsal pagi dan futsal malam terhadap tekanan parsial O_2 dan CO_2 pada individu dewasa muda. Journal of physical education, sport and reaction. Vol.3 No.2 Hal:89-97 e-ISSN:2597-7016 p-ISSN:2595-405