ANNALES

UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA

SECTIO D

MEDICINA

VOL. LX, SUPPL. XVI, N 7 LUBLIN 2006

UNIWERSYTET MARII CURIE-SKŁODOWSKIEJ
AKADEMIA MEDYCZNA
ISSN 0066-2240

ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN - POLONIA
VOL.LXI, SUPPL. XVII, 797 SECTIO D 2006

[1]Akademia Medyczna w Gdańsku, Katedra i Klinika Medycyny Ratunkowej i Katastrof, Gdańsk
[2] Akademia Wychowania Fizycznego i Sportu w Gdańsku, Zakład Fizjologii, Gdańsk.
[1]Clinical Department of Emergency Medicine, Medical University in Gdańsk, Poland.
[2]Department of Physiology, J. Śniadecki University of Physical Education and Sport, Gdańsk, Poland.

ROBERT SZYMCZAK[1], TOMASZ GRZYWACZ[2], ANDRZEJ BASIŃSKI[1], ANNA SZCZĘSNA-KACZMAREK[2]

The impact of the high altitude, hypobaric hypoxia on the chosen physiological parameters

Wpływ wysokogórskiej, hipobarycznej hipoksji na wybrane parametry fizjologiczne

INTRODUCTION

The high altitude tourism is becoming more and more popular among polish citizens. Commercial companies offer an easy access to high altitude trekking and expeditions all over the world. It happens that people just from the office desk go straight to high altitude without any preparation and without knowledge about the influence of the high altitude on their organisms.[2,3]

The aim of this research, which was the part of the Project PHARE 2005 (Polish High Altitude Research Expeditions 2005), was the estimation of the impact of the high altitude, hypobaric hypoxia on the chosen physiological parameters.

MATERIAL AND METHODS

Thirty two members of the Zdobywcy Expedition 2005 volunteered for this study. Among thirty two subjects there were 28 males and 4 females, mean age of the group was 37 ± 9 (SD).

The measurements were done during the Zdobywcy Expedition 2005. The aim of the expedition was a successful climb of the Lobuche East 6119m, the summit in Himalayas in Nepal.

The data was collected every day in the evening at the altitude reached by the strongest group. It means that till the altitude of 4850m there were 32 subjects examined and from 5200m to 6150m there 20 subjects examined. There were done measurements of the arterial oxygen saturation [SaO2], heart rate [HR] and the respiratory rate [RR]. SaO2 and HR were measured using pulseoximetry equipment (Dolphin 2150, AxMediTec Poland). The data was collected in tents (except summit data), after the warming up of the index finger used for the pulseoximetry measurements. The highest SaO2 and lowest HR observed over a 30 seconds interval were recorded for data analysis [1]. RR was measured during one minute by the subjects themselves.

RESULTS

The data show that there is a statistically significant decrease of the SaO2 with the increase of the altitude above sea level (table 1.). There is a statistically significant increase of the HR and RR with the increase of the altitude above sea level (table 1.). The data show a statistically significant increase

of the RR with the decrease of SaO2 at high altitude (table 2.). There is a statistically significant increase of the HR with the increase of RR at high altitude (table 3.).

Table 1. Changes of chosen physiological parameters measured during high altitude expedition compared to altitude

Altitude [m]	Arterial oxygen saturation [%]	Heart rate [beat · min -1]	Respiratory rate [breath · min -1]
1300	96 ± 1	84,8 ± 14	11,5 ± 4
2600	93,9 ± 1,6	80,4 ± 11	13 ± 3,5
3450	89,3 ± 3,9	85,4 ± 14,2	13,1 ± 4
3730	87,8 ± 3,7	88,7 ± 13,1	13,5 ± 4,7
4350	82 ± 6,2	90,4 ± 14	12,7 ± 3,5
4850	77,4 ± 7,9	90,3 ± 13,5	14,2 ± 5,2
5200	73,1 ± 9,4	94,7 ± 10,9	15,8 ± 8,5
5200	72,5 ± 6,2	89,4 ± 13	15,3 ± 4,5
5500	68 ± 8,1	92,2 ± 11,2	15,1 ± 3,6
6150	64,6 ± 7,4	109 ± 17,3	Not measured
4850	82,6 ± 5,5	77,1 ± 12,2	13 ± 3,9
3930	90,4 ± 2,1	86,3 ± 14,3	11,7 ± 3,5
3450	92,1 ± 2,5	80,6 ± 12,5	12,2 ± 4,2
2850	93,6 ± 1,65	86,9 ± 14,5	Not measured
1300	96,8 ± 1,4	75,8 ± 15	11,5 ± 4
	P<0.0005	P<0.0005	P<0.0005

Values are means ± SD. P – statistical significance (paired t – test), comparison of physiological parameter and altitude.

Table 2. Significant differences from SaO2 as determined by paired t-test

Arterial oxygen saturation [%]	Heart rate [beat · min -1]	Respiratory rate [breath · min -1]
	P<0.5	P<0.0005

Table 3. Significant difference from HR as determined by paired t-test

Heart rate [beat · min -1]	Respiratory rate [breath · min -1]
	P<0.0005

There is a significant negative correlation between the altitude above sea level and SaO2 (Fig. 1.)

There is a significant positive correlation between the altitude above sea level and the physiological parameters like HR and RR (Fig. 2.), (Fig. 3.).

There is a significant negative correlation between SaO2 and the physiological parameters as HR and RR at high altitude (Fig. 4.), (Fig. 5.).

There is a significant positive correlation between HR and RR at high altitude (Fig. 6.)

Fig.1. Relationship between altitude and arterial oxygen saturation. [r = - 0.926]

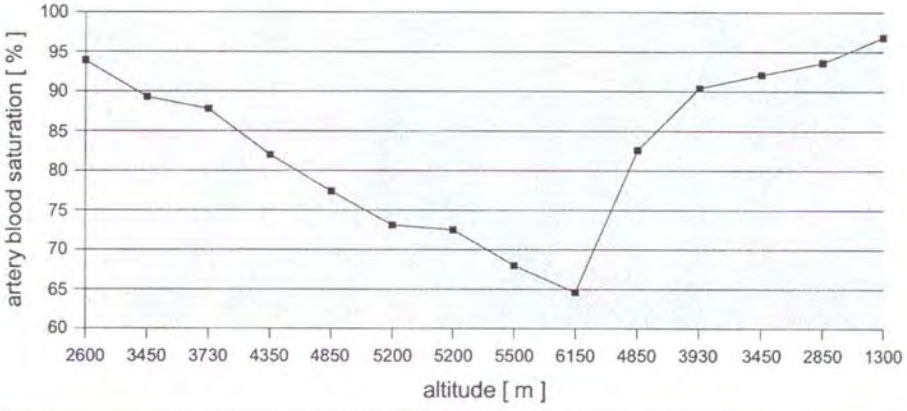


Fig. 2. Ralationship between altitude and heart rate. [r = 0.685]

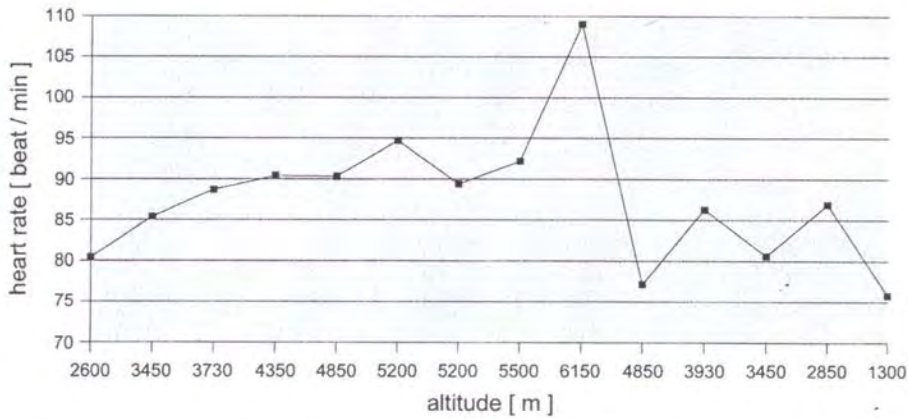


Fig. 3. Relationship between altitude and respiratory rate. [r = 0.792]

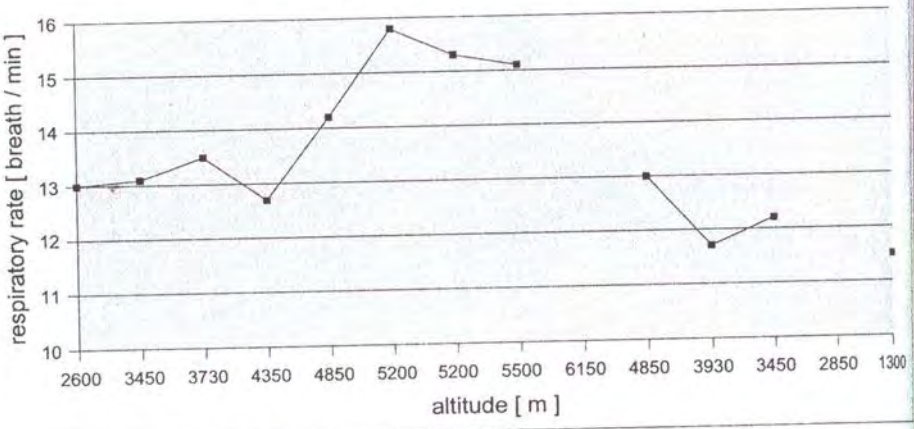


Fig. 4. Relationship between arterial oxygen saturation and heart rate at high altitude. [r = -0.774]

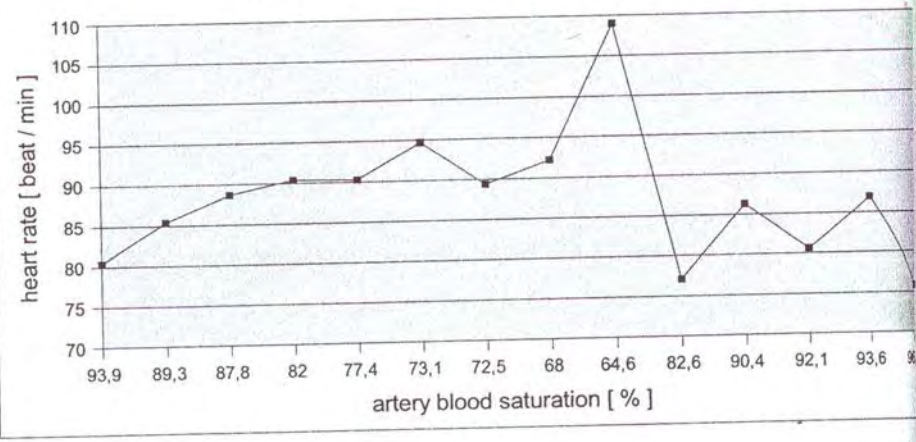


Fig. 5. Relationship between arterial oxygen saturation and respiratory rate at high altitude [r = -0.901]

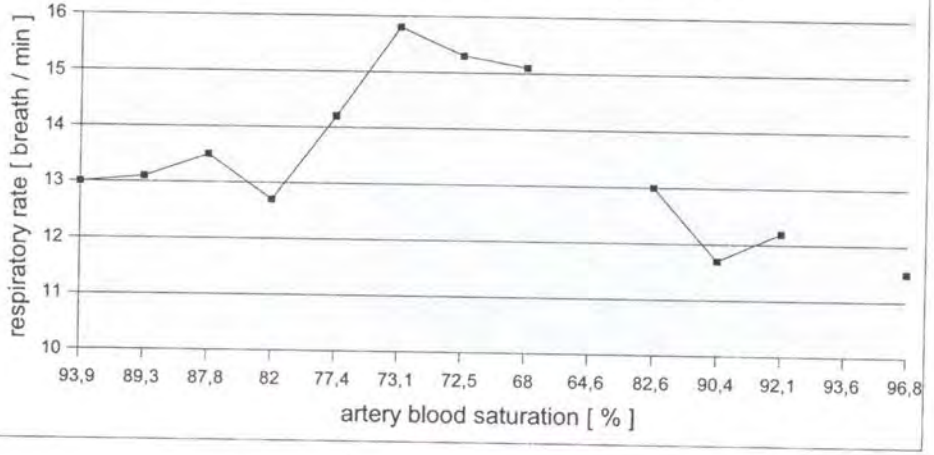
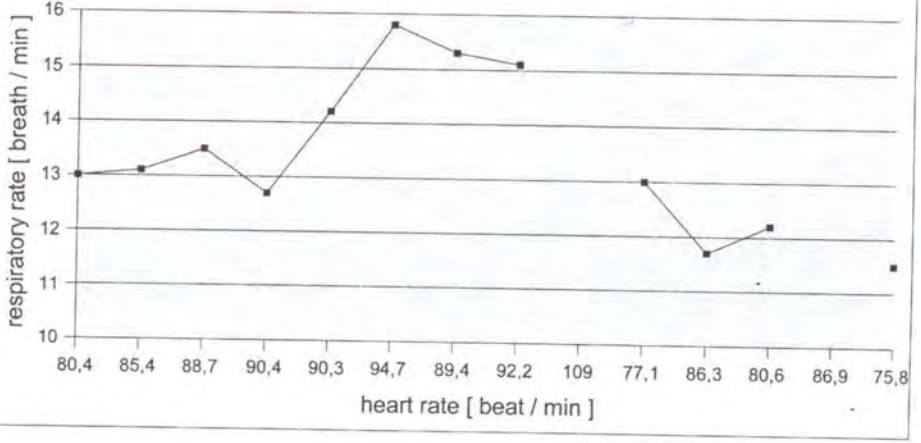


Fig. 6. Relationship between heart rate and respiratory rate at high altitude. [r = 0.702]



CONCLUSIONS

It has been observed a statistically significant correlation between: the altitude above sea level and SaO2 (negative); the altitude above sea level and HR (positive); the altitude above sea level and RR (positive); SaO2 and HR (negative); SaO2 and RR (negative); HR and RR (positive) which confirms a great impact of high altitude hypobaric hypoxia on the physiology of the human organism.

The further research should be conducted to estimate the influence of high altitude hypoxic physiological change on the performance of the humans at high altitude.

People who organize high altitude tourism and those who participate in it have to be aware of and be prepared to face the physiological change in their organism due to high altitude.

REFERENCES

1. O' Connor T., et all., Pulseoximetry in the diagnosis of Acute Mountain Sickness, High Altitude Medicine & Biology 2004, Volume 5, Number 3, p341-349.
2. Plantz H. S., Adler N. J., Medycyna Ratunkowa, 1st polish edition, Urban & Partner 2000, p774-779.
3. Ward M. P., et all., High Altitude Medicine and Physiology, 3rd edition, 2000, p44-97

ACKNOWLEDGEMENTS / FUNDING

Funding and pulseoximetry equipment (Dolphin 2150) was received from AxMediTec Poland, alpine and expedition climbing equipment from Pajak and AMC.

SUMMARY

The high altitude tourism is becoming more and more popular among polish citizens. The aim of the study was the estimation of the impact of high altitude, hypobaric hypoxia on the chosen physiological parameters. There were examined 32 members of the Zdobywcy Expedition 2005 in Himalayas in Nepal. The data consists of arterial oxygen saturation (SaO2), heart rate (HR) and respiratory rate (RR) measurements. The results show significant correlation between: the altitude above sea level and SaO2 (negative); the altitude above sea level and HR (positive); the altitude above sea level and RR (positive); SaO2 and HR (negative); SaO2 and RR (negative); HR and RR (positive) at high altitude. The fact that the high altitude hypobaric hypoxia has a great impact on the physiology of the human organism must be considered by polish high altitude tourists and polish high altitude tourism organizers.

STRESZCZENIE

Turystyka wysokogórska staje się coraz bardziej popularna wśród polskich obywateli. Celem pracy była ocena wpływu wysokogórskiej, hipobarycznej hipoksji na wybrane parametry fizjologiczne. Zbadano 32 członków Zdobywcy Expedition 2005, która odbywała się w Himalajach, w Nepalu. Zebrano dane dotyczące, saturacji tlenu we krwi tętniczej (SaO2), częstości akcji serca (HR) i częstości oddechów na minutę (RR). Analiza wyników wskazuje znamienne korelacje dla: wysokości n.p.m. i SaO2 (korelacja ujemna); wysokości n.p.m. i HR (korelacja dodatnia); wysokości n.p.m. i RR (korelacja dodatnia); SaO2 i HR (korelacja ujemna); SaO2 i RR (korelacja ujemna); HR i RR (korelacja dodatnia) w warunkach wysokogórskich. Fakt, iż wysokogórska, hipobaryczna hipoksja ma ogromny wpływ na fizjologię organizmu ludzkiego powinien być brany pod uwagę przez polskich turystów wysokogórskich i polskich organizatorów turystyki wysokogórskiej.