LOOK ACADEMIC PUBLISHERS
OPEN ACCESS

INTERNATIONAL JOURNAL OF ENVIRONMENTAL & SCIENCE EDUCATION
2016, VOL.11, NO. 15, 8360-8370

Characteristics of the Different Modes of Walking and Hiking Conditions to Optimize the Movement of Tourists in the Desert

Tatiyana Imangulova[a], Aleksandr Makogonov[a], Gulbaram Kulakhmetova[a] and Osman Sardarov[a]

[a]Kazakh Academy of Sport and Tourism, Almaty, KAZAKHSTAN

ABSTRACT

The development of desert areas in the industrial and tourist and educational purposes related to the implementation of physical activity in extreme conditions. A complex set of hot climate causes the body deep adaptive adjustment, impact on health, human physical performance. Optimization of physical activity in hot climates is of particular importance for the tourists and military personnel, the specific activity of which is related to the foot movement with different masses carried goods on different terrain. The methodology is based on the analysis of the results of experimental studies of the optimum speed of movement of a person walking in a desert area, taking into account temperature and weight of cargo carried. The purpose of the study - assessment of the severity of muscle work, depending on the weight of transported cargo, the nature of the soil and the air temperature at the time of walking alone in a desert area. The paper presents experimental data to evaluate the severity of muscle work, depending on the weight of transported cargo, the nature of the soil and the air temperature at the time of walking alone in a desert area.

KEYWORDS
Minute volume of respiration, oxygen consumption, heart rate, energy expenditure, weight of cargo carried

ARTICLE HISTORY
Received 8 June 2016
Revised 14 July 2016
Accepted 20 August 2016

Introduction

The development of oil and gas industry, the development of desert areas with their extreme climate conditions in the tourist and educational purposes, due to the displacement of a large contingent of people for temporary or permanent residence in unusual environments. A complex set of hot climate factors (temperature drop, low humidity, high levels of ultraviolet radiation, social discomfort) causes the body deep adaptive adjustment affects the health, the physical health of people.

Analysis of the literature on the characteristics of human life in the hyperthermic environment shows that, despite numerous studies, many issues

CORRESPONDENCE Tatiyana Imangulova imangulova@gmail.com

related to the regulation of muscle load in a hot climate, not thoroughly studied and therefore are not reported as of conditions, which are required for practical recommendations (Bagrova & Kovalenko, 1987; Ivanov, 1985; Kovalenko & Andropov, 1990).

This problem is very urgent for Kazakhstan, as a significant part of its territory is covered by desert and semi-desert regions, where about 5 million. Man and focus the main oil and gas reserves. Optimization of physical activity in hot climates is of particular importance for the military, labor specificity which is linked to the performance of heavy physical exertion.

The need to develop the problems associated with the optimization of the motor activity of tourists in terms of rental of climate due to the fact that the structure of modern Kazakhstan Tourism 35-40% of its volume is educational tourism, and most attractive objects of this type of tourism are located on the Silk Road, the Kazakh segment of which is 1248 km. The most promising form of organization of travel in these conditions is the optimal combination of motor and hiking. This circumstance dictates the need to develop practical recommendations on the regulation of loads during walking movement of tourists to different ground surfaces, with different weight carried goods due to high summer temperatures.

The effect of elevated temperature on the person are numerous data in the literature. According to modern concepts of vital activity optimum conditions correspond to an air temperature of 20-25 ° C at a relative humidity of 60-85% it (Mammadov et al., 1994). It is believed that there is no functional system of the body that does not react to heat. Hyperthermia affects energy metabolism (Dimri, Maehotra & Sen Gupta, 1980), contributes to the development of hypoxic effects (Tilis, 1964). In conditions of dry and very hot climates a decrease in reserve capacity of the organism (Bagirov, 1977; Sultanov, 1988). Between the rise in body temperature and heart rate there is a close relationship. It is shown that an increase in body temperature by 1 ° C, accompanied by an increase in heart rate to 15-38 beats / min (Sultanov, 1988; Azhaev, 1979; Rowell, Brengelmann & Murray, 1969). In other words, in high ambient temperature conditions the heart rate can be increased by 50-80% to achieve 140-160 beats / min.

Prolonged exposure to the conditions of temperature 35 ° C and above accompanied by a significant reduction in maximum oxygen consumption, deterioration of mental and physical performance (Rahmetov & Hekimova, 1991). In order to avoid heat stroke during exercise at high temperatures it is recommended to stop work at a heart rate of 140 beats / min (Imangulova et al., 2016).

Active tourism and other forms of motor activity in a desert area associated with the movement of the human foot without load and with load on the solid and the sandy, smooth and rough surfaces in a comfortable and extremely high temperatures. However, there are still many questions regarding the assessment of the severity of the implementation of physical activity in these conditions are not well understood. Most of the recommendations are based on studies carried out with the use of thermal cameras, but not in the natural desert environment.

Therefore there is a need for research in the natural hot climates, with a view to a correct study of optimal modes of motor activity of man in the desert.

Methodology

The methodological basis of the study are the principles of objectivity, systematic scientific knowledge, based on an understanding of the inextricable link unity of man and the environment. We used the provisions and laws, founded by renowned specialists in the field of physical culture, tourism, physiology and sports medicine.

During experimental studies have examined the response of the human body to exercise specific to walk without load and extreme load with a load of up to 50% of body weight. After determining the functional parameters specific to a standstill, the tourists several times (20-30 minutes of rest intervals) were the distance of 450 - 500 m. To register the passage of time and walking speed was calculated that differs from 4 to 7 km / h.

Determined respiratory minute volume, oxygen consumption, heart rate, energy expenditure.

The studies were conducted in Almaty and in the conditions of the desert. Fence exhaled air samples in the Douglas bag was carried out for the last minute of walking alone. The sample of 50 healthy men aged 25 to 45 years. 4 A series of studies related to the assessment of energy expenditure in different modes of human walking in the desert. In particular, we studied the influence of the mass of the cargo transported by walking on hard and sandy soil at a comfortable and high temperature air and the duration of the effect of distance and weight of the cargo transported on the energy cost of exercise.

Results and Discussion

In the first series of studies examined the effect of the mass of the cargo transported by walking on hard ground. Research results in terms of thermal comfort indicate that the load during walking at a speed of about 6 km / h on a flat solid surface directly depends on the mass of cargo transported. In particular, when the load increases from 20 to 35 and 50% by weight of oxygen consumption increases at 8.2 and 25.6%, respectively (Table 1). Energy spending per kg of body weight with an increase in transported cargo also increased by 8.1 and 26.2%, respectively.

Table 1. Indicators breathing, gas exchange and energy costs among tourists

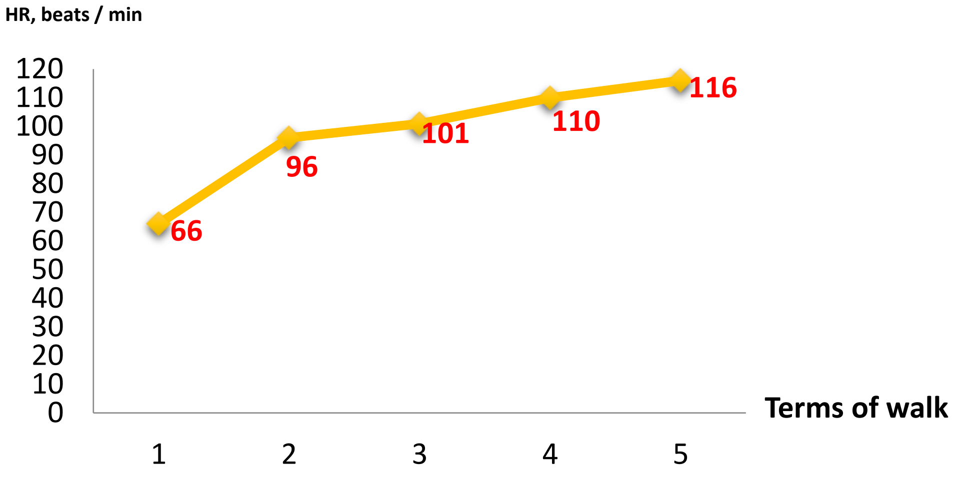
Indicators		Condition of observation *							
		1		2		3		4	
		X	m(x)	X	m(x)	X	m(x)	X	m(x)
MVR, л (BTPS)		10,3	0,7	32,4	1,38	34,4	1,36	37,4	4,05
oxygen consumption	ml / min	370	28	1290	64	1440	62	1680	66
	ml / kg	5,02	0,53	17,3	0,42	19,3	0,39	22,7	1,50
	% IPC			34,5	2,5	37,5	1,36	43,7	1,42
OS, л/л (BTPS)		28,7	1,34	25,3	1,48	24	1,40	22,9	0,76
Energy costs	kcal / m	1,8	0,13	6,45	0,28	6,98	0,29	8,1	0,33
	kcal / kg	24,4	2,56	86,6	2,86	93,6	1,82	109	7,37
	kcal / km			64,5	2,79	69,8	2,96	81,0	3,28

kcal / km x kg'1	0,86	0,03	0,93	0,02	1,09	0,07

Indicators breathing, gas exchange and energy expenditure in Tourists at rest and during uniform (speed of 6 km / h) walking alone on a firm and level surface with a load-time personal mass in terms of thermal comfort (n = 10)

*1- The state of rest; 2,3,4 walking with a backpack weighing 20, 35 and 50% of body weight, respectively,.

In studying the effect of walking on flat and hard surface at a speed of about 6 km / h in conditions of high temperature (350 ° C) was added mode of walking alone is not easy (Fig.1,2.).



*walk Terms: 1 -up to load; 2 - walking without a load; 3, 4, 5 - walking with a load weighing 20, 35 and 50% of body weight.

Figure 1. The heart rate during the walking movement of tourists on a flat, hard surface with varying load weight at a temperature of 35-40 °.

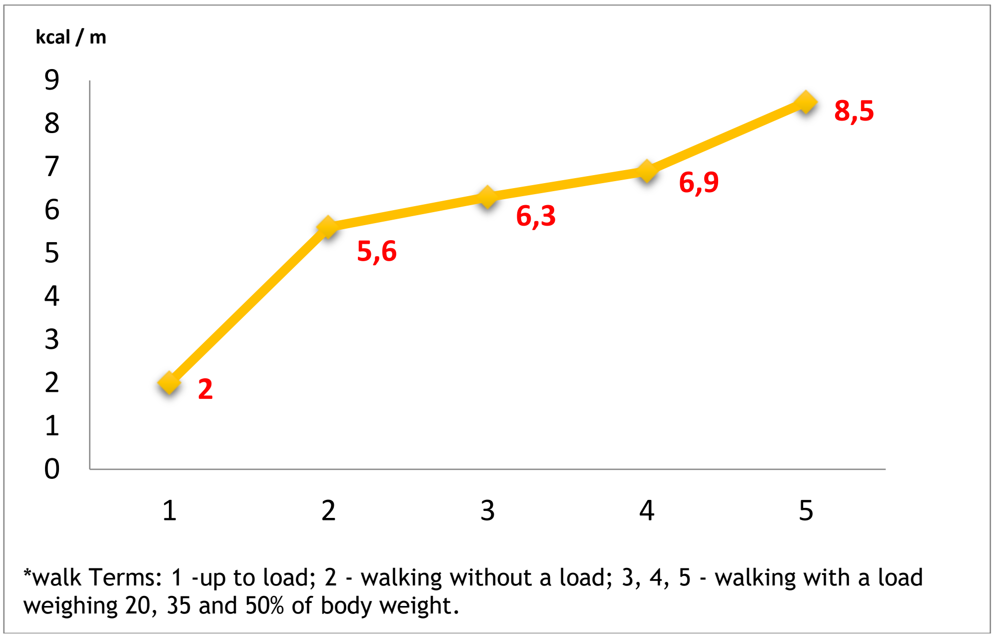
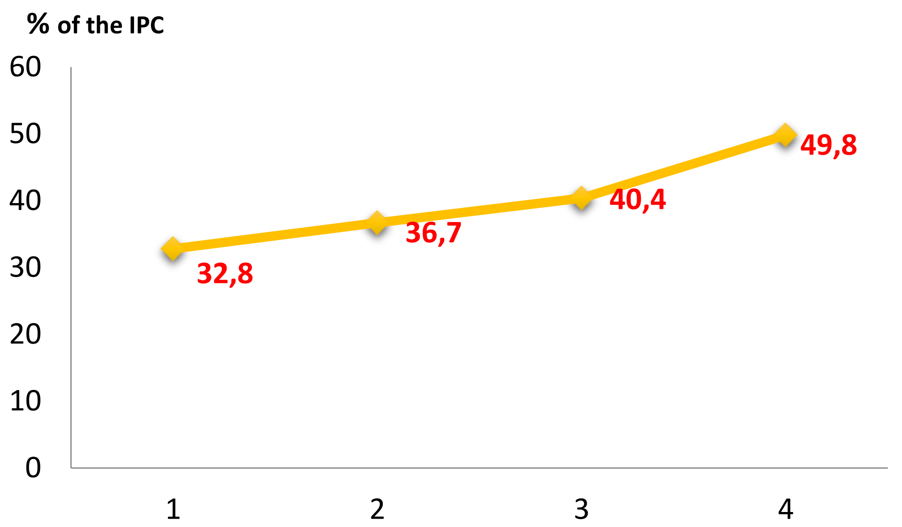


Figure 2. Energy expenditure during walking movement of tourists on a flat, hard surface with varying load weight at a temperature of 35-40 °.

If we consider the human reaction to the increase in the weight of cargo carried on walking towards the light, it is possible to note the following. In fact, if the backpack weight is 20% of the body weight, the heart rate increased by only 5.8%, while increasing the load up to 35 and 50% of the body weight increases the heart rate by 15.4 and 20.8% respectively ($P < 0.05$). As the weight of the load carried by significantly increasing respiratory minute volume. Thus, its growth when walking with the load 20, 35 and 50% by weight of 8.7, 19.8 and 36.2% respectively. Consequently, between increasing weight of the cargo transported and increasing ventilation nablyuda¬etsya dependence, which is close to linear. Increase in oxygen consumption during walking with increasing load weight has a more complex dynamic. With an increase in transported cargo up to 35% of body weight observed li¬neyny increase in oxygen consumption, averaging 7.7 ml of one percent the mass of the load growth. In that case, if the load exceeds 35% of the body weight, the oxygen flow rate increases exponentially. In the latter case, one percent growth in cargo weight on average 22.6 ml of oxygen.

An overview of the load on the body, associated with an increase in the mass of transported cargo, gives integral criterion, which is the indicator of aerobic capacity of muscle work, defined as the ratio of the current to the maximum oxygen consumption. Observations indicate that aerobic power walking alone increases with increasing weight of the cargo. For example, if while walking light match 32.8% of the IPC, during the movement with a load weighing 50% of the body weight load capacity reached 49.8% of the IPC (Figure. 3).

Figure 3. Aerobic power walking alone tourists on a flat and hard surface without load and with a load of different masses at an air temperature of 35-40% (% of the IPC).



*walk Terms: 1 - walking without a load; 2, 3, 4 - Walking with a load weighing 20, 35 and 50% of body weight.

The most significant increase in muscle work, aerobic capacity observed is given by increasing the transported cargo from 35 to 50% by weight of the human body.

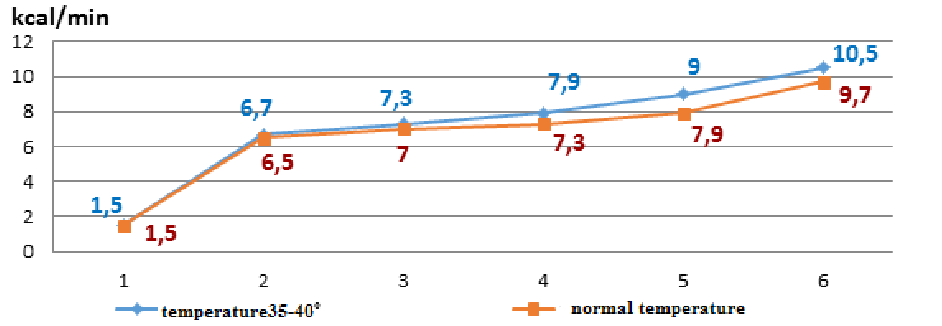
The intensity of muscular work load in this mode usili¬vaetsya, judging by the increase in aerobic capacity works twice as fast as with an increase in the load from 20 to 35% of body weight.

The study results also suggest that increasing the load to 35% of body weight accompanied by a moderate increase in power consumption and increase its essential in the case of increasing load mass to 50% by weight. Thus, an increase in the load of up to 20 and 35% of body weight is accompanied by increased energy expenditure by 12.6 and 24.2% in relation to the level of energy expenditure during walking lightly, and increase the mass of the load to 50% of body weight is associated with an increase in energy expenditure on 52,1%.

The effectiveness of breathing in humans during walking with the load and without it, according to the ventilation equivalent, as a rule, significantly higher than the rest. Regarding the impact of the mass of cargo carried on the efficiency of breathing, the comparison of data obtained during walking and light with a cargo compared with the state of rest, allows us to give a positive assessment, as ventilation reduction equivalent averages 17.4-24.5%.

At the second stage of the study examined the effect of the mass of the cargo transported by walking on sandy soil. The study of human response to pedestrian movement on the sandy ground in the desert area was carried out in conditions comfortable (25 ° C) and elevated (35-38 ° C) temperature. The results of these observations are presented in Fig.4.

Figure 4. Effect of different conditions on sandy soil walk at a comfortable temperature and air temperature of 35-40% on energy expenditure of tourists.



*walk Terms: 1 - up to load; 2 - walking without a load; 3, 4, 5 - walking on a flat surface with the load 20, 35 and 50% by weight; 6 - walking on the rise 15 ° with a load of 35% of body weight.

From the analysis of the data table (3 that when walking in a comfortable temperature with a load of 20% of body weight energy expenditure per kilometer path towards increasing pedestrian movement without cargo by 9.8%, ie one percent cargo growth is accompanied by increased energy expenditure on 0.49%.

Increased load of up to 35% of body weight increases the energy consumption of the tourist by 20.1% compared to walking without luggage. In other words, in this case one percent the mass of transported cargo growth cost increasing human energy expenditure for kilometers by 0.57%. A significant increase in energy consumption is accompanied by walking on sandy soil with a load of 50% of body weight. Despite the significant, amounting to 10% decrease in the speed of movement with such a burden with respect to the light walking, increase energy expenditure per km of railway was 35.7% or an average of 0.71% per percentage weight gain transported cargo.

Walking along the sandy ground at high temperature air (Figure 4), accompanied by the reactions to the increasing weight of carried goods similar to those that occurred at a comfortable temperature. So, when walking with a load of 20% of the body weight, energy expenditure increases to kilometers, compared to pedestrian movement light, at 10.8%, ie one percent of cargo weight gain corresponds to an increase of energy consumption by 0.54%. In that case, if the load reaches 35% of the body weight, the energy consumption during walking increased by 21.8% or one per cent increase in the mass of cargo transported is accompanied by increased energy expenditure by 0.62%. However, the most severe burden a person experiences when the goods carried is 50% of body weight. Even though a significant reduction (7.5%), walking speed in relation to pedestrian movement without load, energy expenditure in this case increases by an average of 45.9% and an increase in energy consumption by one percent the mass of the load growth is on average 0, 92%.

If walking on the rise 15 ° is associated with a load of 35% of body weight, it dramatically increases the cost of energy path. In particular, the significantly reduced (by 25.2%), compared with walking light, the speed of movement on the rise, energy expenditure increased by 55.8%.

Thus, the results of the observations as a whole suggest that the increase in weight of carried goods to 35% both when walking on hard and sandy surface, accompanied by a moderate increase in energy consumption and a significant growth with its cargo of 50% of body weight.

For the comparative assessment of the severity of pedestrian movement on hard and sandy soil conditions in the desert A separate series of studies. The study involved a group of tourists from eight people who have compared the reaction to the burden of foot movement on hard and sandy soil (in a desert area) and light with a cargo of 20, 35 and 50% of body weight. The results of these observations are presented in Table 2.

Table 2. The reaction of the organism to the load of tourists associated with the re foot traffic without load with load and solid sandy soil under thermal comfort (n =8)

indicators of biometrics	surface texture							
	hard ground				sandy soil			
	IPC, l	oxygen consumption, ml / min	OC, l/l	energy consumption kcal / min	OC, L	oxygen consumption, ml / min	E,/l	energy consumption kcal / min
Walking at a speed of 5.6 km / hour unladen								
X	4,9	1125	22,16	5,6	36,5	1350	27,03	6,74
m (x)	1,17	28	1,06	0,13	1,38	69	1,41	0,342
Walking at a speed of 5.4 km / h with load mass of 20% of body weight								
X	7,3	1214	22,49	6,07	41,6	1440	8,9	7,19
m (x)	1,81	49	0,98	0,22	2,69	101	0,8	0,49
Walking at a speed of 5.2 km / h with a load weight of 35% of body weight								
X	9,9	1277	22,52	6,4	42,9	1550	27,7	7,72
m (x)	2,10	56	0,13	0,247	2,98	57	1,5	0,27
Walking at a speed of 5 km / h with load mass of 50% of body weight								
X	1,6	1405	22,49	7,03	47,55	1746	7,3	8,7
m (x)	2,65	119	1,143	0,5	3,13	107	1,09	0,54

As can be seen from Table 2, light while walking at a speed of 5.6 km / h on the sandy ground, compared to move the solid surface is significantly enhanced load on the human respiratory apparatus, according to an increase in respiratory minute volume, increase in oxygen consumption energy expenditure by 46.6; 20 and 20.5%, respectively. In other words, even fast walking without a load on the surface of the sand is heavy physical load. In the event that foot movement on sandy soil associated with carrying the load of 20% of body weight, the load growth on the body compared with walking on a hard surface, judging by the increase in oxygen consumption and energy expenditure remains the same as when walking light.

An increase in the mass of the cargo carried by up to 35% of body weight walking on sandy soil in energy costs a person against "expensive" at 21.1%. That is, the previous effect of increasing the load on the body while walking on sandy soil, which has been installed at the two previous modes of walking alone. Walking with a load of 50% of the body weight on the sandy soil is a significant burden on the human body. As shown in Table 2. The energy expenditure reaching 8.7 kcal / min, according to the existing classification refers to the very heavy muscular work. Compared to walking on a hard surface with the same load of energy expenditure increased by 23.9%.

Thus, walking on the surface of the sand unloaded and loaded with 20, 35 and 50% of the weight load increases the energy cost compared to foot movement on the solid surface by an average of 20-25%. In this context, the only way to optimize the load while walking on sandy soil in the desert is to reduce the speed of movement.

On the basis of summarizing and analyzing the results of experimental studies the optimal speed of movement of a person walking in a desert area, taking into account temperature and weight of cargo transported (Table 3).

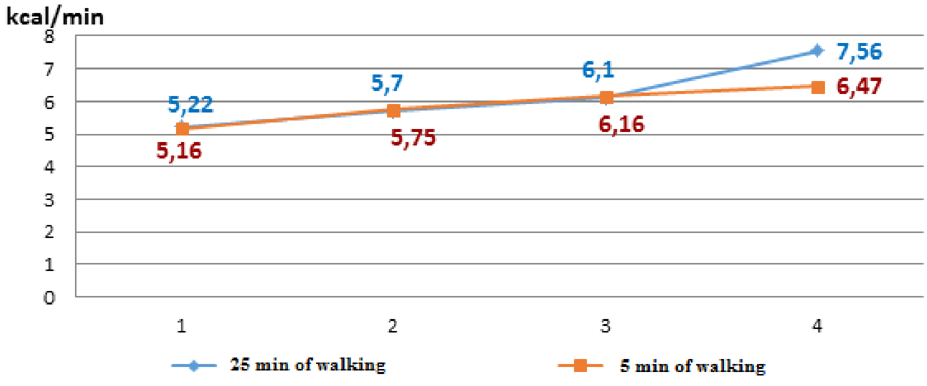
Table 3. The optimum speed of movement of a person walking in a desert area, taking into account temperature and weight of cargo transported

Terms of walk		walking speed		Indicators			
		km / h	m / s	HR, beats / min	oxygen consumption ml / min	oxygen consumption ml / kg	energy consumption kcal / min
thermal comfort (20-25⁰)							
without a load		4,5	1,25	102-108	1080	16,0	5,4
Loaded (percentage by weight)	20	4,1	1,14	102-108	1080	16,0	5,4
	35	3,6	1,0	102-108	1080	16,0	5,4
	50	3,2	0,89	102-108	1080	16,0	5,4
High temperature (35-40 ⁰ C)							
without a load		4,4	1,22	108-114	1080	16,0	5,4
Loaded (percentage by weight)	20	3,9	1,08	108-114	1080	16,0	5,4
	35	3,5	0,97	108-114	1080	16,0	5,4
	50	2,9	0,80	108-114	1080	16,0	5,4

In the course of our observations also studied the effect of the duration of walking in a desert climate in the energy cost burden. Studies were carried out on the sandy road while walking without load and with a load of 20, 35 and 50% of body weight. The study included healthy young men, who in the fifth and the twenty-fifth minute walk was determined by oxygen consumption, which is calculated on the basis of energy expenditure.

It follows from Figure 5 that, as during walking without a load, and with a load of up to 35% of body weight, oxygen consumption and energy expenditure on the 5th and 25th minutes virtually identical. A significant increase in energy expenditure by 25 minutes, walk towards the 5th minute is observed only when traveling with a load weight of 50% of body weight. Increase in oxygen consumption is 1.7,5%, while energy consumption increased by an average of 16.1%.

Figure 5. Effect of walking without a load and with a load of 20, 35, 50% of the body weight on the energy expenditure of tourists in desert.



*walk Terms: 1 - walking without a load; 2, 3, 4 - Walking with a load weighing 20, 35 and 50% of body weight.

Based on the results of observations carried load in these conditions, must not exceed 35% of the weight of the human body. In this context, it is very important to determine the optimal weight of the load carried by both at the individual and group traveling on foot. On the basis of the results of research to develop a formula for calculating the optimal weight transported cargo:

P = 3 x FR130, where P is load mass in kg;

3-empirical coefficient; FR130 - physical performance when the heart rate 130 beats / min, kgm / kg.

Conclusions

1. An increase in cargo transported in a desert area up to 35% of body weight observed a linear increase in oxygen consumption, averaging 7.7 ml of one percent the mass of the load growth. If the load exceeds 35% of the body weight, the oxygen consumption increases exponentially. On the one percent growth in cargo weight on average 22.6 ml of oxygen.

2. Walking on sandy surfaces without load, with the load 20, 35 and 50% of the weight load increases the energy cost compared to the movement of a solid surface by an average of 20-25%. In this context, the only way to optimize the load while walking on sandy soil is to reduce the speed of movement.

3. Based on the results of studies designed optimum speed of movement of a person walking in a desert area, taking into account the temperature and weight of cargo transported, as well as a formula for calculating the optimal weight carried goods.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Tatiyana Imangulova - Candidate of Pedagogical Science, Dean of the Faculty of Tourism in the Kazakh Academy of Sports and Tourism, Almaty, Kazakhstan.

Aleksandr. Makogonov - doctor of pedagogical sciences, professor at Kazakh Academy of Sports and Tourism, Almaty, Kazakhstan.

Gulbaram Kulakhmetova - PhD at Kazakh Academy of Sports and Tourism, Almaty, Kazakhstan.

Osman Sardarov - PhD at Kazakh Academy of Sports and Tourism, Almaty, Kazakhstan.

References

Azhaev, A. N. (1979). Fiziologi-geneticheskie aspekty dejstvija vysokih i nizkih temperatur. *Problemy kosmicheskoj biologii.* Moskva: Nauka, 390 p.

Bagirov, B. G (1977). *Chelovek i zharkij klimat.* Ashhabad: Ylym, 275 p.

Bagrova, N. D. & Kovalenko, V. P. (1987). Vlijanie vysokoj temperatury na funkcional'noe sostojanie i rabotosposobnost'. *Voenno- medicinskij zhurnal*, *4,* 35-36.

Dimri, G. P, Maehotra, M. S. & Sen Gupta, J. (1980). Altratio in aerobic- anaerobic proportion of metabolism during work in heat. *Europ. J. Appl.Phiysiol*, *2*, 43-50.

Imangulova, T., Makogonov, A., Zakiryanov, B. & Makogonova, T. (2016). Influence Altitude and Length of Stay in the Mountains of Physical Performance Tourists *International Journal of Science and Environmental Education, 11,* 7271-7277

Ivanov, Ju. A. (1985). Jeksperimental'noe obosnovanie rezhima trenirovok i metody kontrolja pri uskorennoj adaptacii k zhare. *Voenno-medicinskij zhurnal, 11,* 47-49.

Kovalenko, V. P. & Andropov, A. S. (1990). Vlijanie uskorennoj adaptacii i rabotosposobnost' voennosluzhashhih v uslovijah zharkogo klimata. *Voenno-medicinskij zhurnal*, *11,* 48-52.

Mammadov, I. M., Grigor'jan, A. G., Frank, Je. I., Kurbanova, L. M. (1994). Prognosticheskaja ocenka sostojanija adaptacii ljudej, prozhivajushhih v uslovijah aridnoj zony. *Materialy VII Vserossijskogo simpoziuma «Jekologo- fiziologicheskie problemy adaptacii»*, Moskva, 190-192.

Rahmetov, B. R. & Hekimova, A. R (1991). Sostojanie teplovoj ustojchivosti i rabotosposobnosti cheloveka pri adaptacii k uslovijam aridnoj zony. *Syezd fiziologov Srednej Azii i Kazahstana*, 2-73.

Rowell, H. B., Brengelmann, G. H. & Murray, J. A. (1969). Cardiovascular responses to sustained high tempe rature in resting man. *J. Appl. Physiol, 5,* 373-690.

Sultanov, F. F. (1988). Jekologo - fiziologicheskie /aspekty zhiznedejatel'nosti cheloveka v aridnom regione v uslovijah nauchno-tehnicheskoj revoljucii. *Vsesojuznyj simpozium «Jekologo-fiziologicheskie problemy adaptacii»*. Moskva, 221-222.

Tilis, A. Ju. (1964). *Gemodinamika i biohimicheskie sdvigi pri solnechno- teplovom peregrevanii.* Tashkent: Medicina, 160 p.