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FUNCTIONAL CAPACITY AND EXERTION TWO DIFFERENT MODELS WALKING INCLINEABSTRACT

Abstract

Functional capacity and rated perceived exertion during two different models of the ascent walking are compared in this work. 28 students of Faculty of physical education (aged 21.4, ±1.27) were examined for that purpose. Streamlined treadmill managed by a diagnostic device Fitmate Med (Cosmed) was used for both walking protocols and maximal oxygen expenditure (VO2max) and maximal heart rate (HRmax) were recorded. After each protocol, the examinees expressed their rated perceived exertion (RPE). After the first measuring, when the examinees chose the walking model, there was a 12-minute training of set ascent walking model; then the second measuring followed, when the examinees practised the set walking model. Submaximal test "Chester treadmill walk test" was applied on both measuring activities. Acquired data were analysed by kinematic method and statistic procedures. In conclusion, differences between examined walking models do exist, i. e, the set model requires larger energy expenditure amount and causes lower level of rated perceived exertion.

***Key words**: ascent walking, oxygen expenditure, heart rate*

1. INTRODUCTION

When commenting the main characteristic of human as species, some people would mention the cerebrum, others – the ability of making sophisticated tools and their use, and some would emphasise moving in vertical position – walking (Lovejoy, 1988). Walking is a cyclic activity where one step follows the other according to the continuous pattern and, biomechanically classified, it falls into the category of basic movements (Mikić and Bjeković, 2004). Although not clear enough, generally speaking, people choose the way of walking that provides the optimal energy expenditure. It is assumed that a human uses proprioceptive feedback to identify economic forms of walking (Hubbuch, Bennett and Dean, 2015). As every physical activity, walking requires a certain amount of energy expenditure. It is well known that the body has the lowest level of energy expenditure when the human chooses the walking type. (McNeill, 2002; Mikić and Bjeković, 2004; Willis, and Herman, 2005). A lot of factors influence the energy expenditure. One of them is a type of walking i. e. body barycenter movements, lenght and speed of steps, the percentage of body fat (Pandolf et al. 1977 according to Silder, Besier & Scott, 2012). Walking characteristics, such as the change of self-chosen walking type (Donelan et al. 2001), less or no arm movements (Umberger, 2008), as well as walking with knees bent (Waters and Mulroy, 1999), influence the amount of energy expenditure. Walking in different speed, up and down the ascent, with or without exertion, also influences the amount of energy expenditure i. e, those parameters determine the energy resources (Entin, Gest, Trancik and Coast, 2010).

Taking into account that the oxygen expenditure (VO2max) and heart rate (HR) are the parameters for the energy expenditure estimation, they were used for that purpose as well as the comparison, which was the prior aim (Keytel, Goedecke, Noakes, Hiiloskorpi, and Lambert 2005; Hiilloskorpi, Pasanen, Fogelholm, Laukkanen and Mänttäri 2003).

The relief with a lot of mountains, hills, rivers and mostly covered with forested areas as well as other natural-geographic characteristics of Bosnia and Herzegovina and countries from that region are a fertile ground for the development of walking as a source of sports recreation. According to the various forms and qualities of the terrain and the walker's physical abilities, there are various walking techniques: along the roads and paths, up and down the hill, along the rocky road, along the grassy terrain, through the bushes, into the woods, in the snowy weather ... (Kalem, Trivun, 2007).

2. METHODS

The research samples were 28 students of Faculty of physical education and sport in Banja Luka (aged 21.4, ±1.27).

During first and second measuring, the examinees were submitted to the submaximal walking test „Chester treadmill walk test“ (Sykes, 2007), which included 12-minute walking up the ascent 0, 3, 6, 9, 12, 15% (two minutes per ascent), speed 6.2 km/h. The test was completed on the streamlined treadmill managed by a diagnostic device Fitmate Med (Cosmed) which recorded the data for VO2max (ml/kg/min) and HRmax (per min). After both measurings, the examinees showed RPE 6 – 20 (Borg, 1982).

After the first measuring, where the examinees applied the self-chosen walking type, there was a training program about the new model of ascent walking within the time of 12 school lessons. The first lesson consisted of the audio-visual presentation of the set ascent walking model. The second lesson consisted of the presentation of ascent walking with practical exercises that the examinees had to pass during the training. The practical exercises included ascent walking with movements similar to the required model's: walking on the flat surface with knees bent, walking on the flat surface with knees bent with the emphasis on vertical torso and arm movements, walking on the flat surface setting the whole foot on the ground, walking up the stairs, walking on the treadmill with knees bent, walking on the treadmill with knees bent with the emphasis on vertical torso and arm movements.

Later, the examinees practised the set ascent walking model within the time of 10 school lessons that were held every other day within the time of 2 school lessons. The second measuring followed the assessment of the set model practice. Three experts assessed the set model practice. Two experts from the area of mountaineering and one from the area of athletics assessed fast walking. The assessment scale ranged from 1 to 5, and the average mark for practice was 3.9.

THE DESCRIPTION OF THE ASCENT WALKING MODEL

The kinematic method implies differences between the self-chosen ascent walking type, i. e. model 1 and the set ascent walking type, i. e. model 2. When analysing a human movement, a musculo-skeletal system could be presented as a line of banded body segments for creating a virtual model of a human in space (Robertson, D. G. E., Caldwell, G., Hamill, J., Kamen, G. and Whittlesey, S. N. 2004, according to Zerpa, C., Lees, C., Patel, P., Pryzsucha, E. 2015). The examinee photograph was isolated from the video clip at the exact moment when the front foot heel stepped on the treadmill, making a so-called initial contact (Sutherland, Kaufman and Moitoza, 1994). 11 reflective markers were set on the right side of the body to enable the easier insight in the video as well as the photograph. A protractor was centered on the anterior superior iliac spine, according to Davis's protocol (Bell, A.L., Pedersen, D.R. and Brand, R.A. 1990, According to Tranberg, 2010, p 22; Medved, Kasović, 2007).

MODEL 1, SELF-CHOSEN ASCENT WALKING MODEL

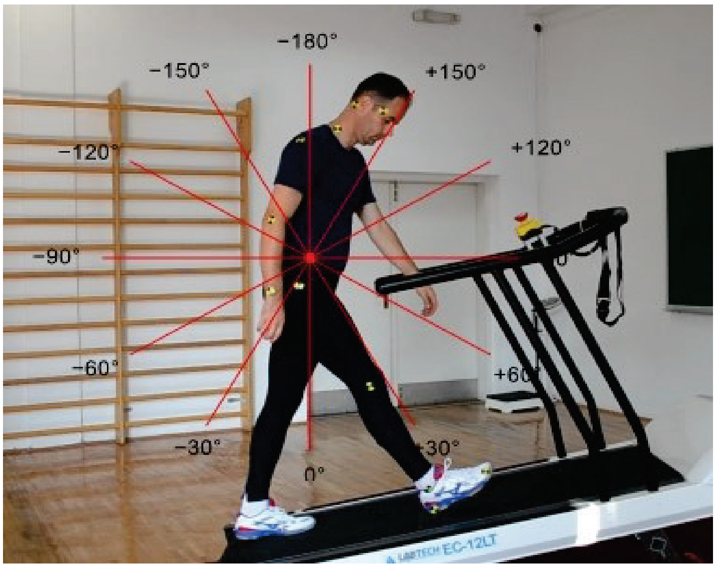

Figure 1. self-chosen ascent walking 15%; model 1.

Figure 1. (self-chosen ascent walking 15%; model 1) shows the body position in the walking phase – the initial contact. The details observed from the model 1:

1. front foot stretched at the knee joint at the moment of the contact with the surface
2. front foot toes are lifted 4 to 8 cm by comparison to the model 2
3. torso is slightly bent between 60º and 80º towards the horizontal
4. head is slightly bent for 15º towards the vertical
5. shoulders are bent to the front and lowered by comparison to the regular posture (Mikić, Bjeković, 2004, p 143: Jovović, 2008 p 100) and hands are loose.

MODEL 2, SET ASCENT WALKING MODEL

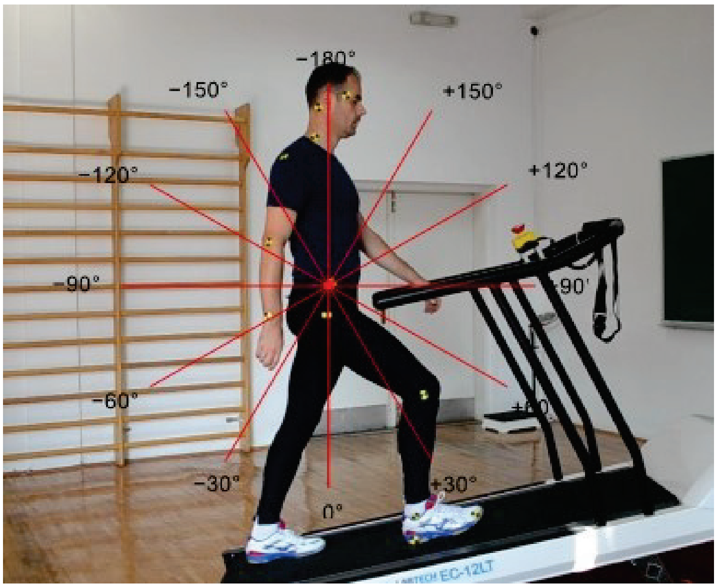

Figure 2. set acent walking 15%; model 2.

Figure 2. (set acent walking 15%; model 2) shows the body position in the walking phase – the initial contact. In this phase, the front foot heel makes the initial contact to the surface. The video clip shows the protractor centered on the anterior superior iliac spine, according to Davis's protocol (Bell, A.L., Pedersen, D.R. and Brand, R.A. 1990, according to Tranberg, 2010, p 22; Medved, Kasović, 2007). The details observed from the model 2:

6. front foot bent at the knee joint at the moment of the contact with the surface and the lower leg is vertical
7. front foot toes are up to three (3) cm above the surface
8. torso is vertical towards the horizontal
9. head is slightly bent for 15º towards the horizontal
10. shoulders are in the regular posture (Mikić, Bjeković, 2004, p 143: Jovović, 2008 p 100) i. e. open, and hands are controlled by the shoulder posture itself.

3. RESULTS

Tabel 1. Descriptive statistic parameters with K – S the allocation normality test

	H	***Arithmetic mean***	***Min***	***Max***	***Study lapse***	***K-S Test***
VO2max1 (ml/kg/min)	28	56.35	40.60	70.30	6.34	.406
VO2max2 (ml/kg/min)		56.67	47.10	68.00	5.02	.502
HRmax1 (per/min)	28	176.68	152.00	205.00	12.88	.788
HRmax2 (per/min)		180.32	149.00	205.00	13.50	.829
RPE1	28	14.89	11.00	20.00	2.36	.143
RPE2		14.07	9.00	18.00	2.37	.655

Tabel 1. shows the descriptive statistic parameters with K – S the allocation normality test which proves that the arithmetic means at variables VO2max and HRmax are higher after the second measuring, while the same value is decreased at variable RPE. Kolmogor-Smirnov test shows the disposition normality for all the variables.

Tabel 2. Values of T – test of paired samples

			Confidence interval				
	arithm. mean	standard deviation	lower	upper	t	degree of freedom	significance
VO2max - VO2max2	-0.491	1.814	-1.195	0.211	-1.434	27	.163
HRmax - HRmax2	-3.642	7.02	-6.366	-0.918	-2.744	27	**.011**
RPE – RPE2	0.821	2.34	-0.086	1.729	1.856	27	.074

Tabel 2. shows values gained by T test of paired samples, i. e. the values of the first and the second measuring. Concerning the HRmax variable (HRmax-HRmax2= **.011**), there is a statistically significant difference between the first and the second measuring, and according to the negative arithmetic mean, the conclusion is that the heart rate was significantly higher during the second measuring. Variables VO2max and RPE showed negligible differences between the first and the second measuring, while the arithmetic mean during the second measuring proved to be higher at VO2max and lower at RPE.

4. DISCUSSION

Research has been done to prove differences of certain functional capacities of the examinees practising two ascent walking models as well as their exertion perception. The kinematic analysis confirmed the model differences according to the position and movement of body segments. The model 1 (figure 1.) shows the head bent towards the torso making large amplitudes (back and forth) during the walking cycle, while the model 2 (figure 2.) shows the head in regular posture with small amplitudes while moving back and forth. Shoulders are closed and relaxed during the model 1, therefore they affect arm movements in the antero-sagital space (in front of the body), while during the model 2, shoulders are in regular posture and therefore affect arm movements in antero-postero-sagital space (in front of and behind the body). Torso is bent and makes large amplitudes like the head, while in the model 2 it is in regular posture, rotating the vertical axis. Front foot in the model 1 is stretched at the moment of the initial contact and in the model 2 it is bent in knee joint. In the model 1, the initial contact is made by the heel top, so toes are high above the surface; in the model 2, the contact is made almost by the whole foot, i. e. only toes do not touch the surface.

Descriptive parameters of the functional capacity status from the first and the second measuring are showed in table 1. Increased exertion is confirmed by the higher values of the variables VO2max and HRmax during the second measuring. The interesting fact is, that despite the increased exertion during the second measuring, i. e. using the model 2, the RPE arithmetic means are lower during the second measuring. The implication is that the level of rated perceived exertion of the examinees was lower during the walking model 2. Lower arithmetic means during the first measuring could be explained by the fact that the examinees, during the walking model 1, had lower amount of energy expenditure, precisely for the type of walking they chose, which follows the researches done so far (Pandolf et al. 1977, according to Silder, Besier & Scott, 2012). Lower arithmetic means during the first measuring could be proved, which kinematic analysis showed, by making less arm movements or not at all, (Umberger, 2008) and they also affect the energy expenditure. Higher arithmetic means during the second measuring could be the result of the step length change, i. e. the step length decrease in the model 2, and therefore increasing the number of steps for the same length, which also follows the researches done so far (Donelan et al. 2001). Using the model 2, bending the front leg knee was perceived, and that affected the step length decrease which brings us to conclusion that there was a need for more steps. Walking characteristics, such as the chosen step speed and walking with knees bent (Waters and Mulroy, 1999), also affect the energy expenditure change while walking.

Table 2 shows the values of T – test of paired samples. Negative arithmetic means imply higher values gained by the second measuring, i. e. using the model 2, in which there is a statistic significance of the paired variable samples HRmax (HRmax-HRmax2= **.011**), and the insight in positive arithmetic sign brings us to conclusion that higher heart rate was necessary during the second measuring. It is well known that the body uses less energy if the examinee chooses the walking speed (McNeill, 2002; Mikić and Bjeković, 2004; Willis, Ganley & Herman, 2005; Russell & Apatozcky, 2016). Considering the fact that the walking speed (6,2 km/h) was constant during the walking on the treadmill, there is a conclusion that the examinees had lower amount of energy expenditure, which follows the researches done so far (Pandolf et al. 1977, according to Silder, Besier and Scott, 2012). The increase of energy expenditure is also a result of more arm movements during the model 2 (Umberger, 2008; Mascherini, Battiston, Salvo and Galanti 2015), and comparing it with the model 1. Using the model 2, bending the front leg knee was perceived, and that affected the step length decrease which brings us back to conclusion that more steps were necessary. Walking characteristics, such as the chosen step lenght (Donelan et al. 2001), and walking with knees bent (Waters and Mulroy, 1999), also affected the energy expenditure change while walking.

5. CONCLUSION

In conclusion, the differences between examined walking models do exist, i. e, the set model requires larger amount of energy expenditure and causes lower level of rated perceived exertion. There is a possibility that the examinees, adopting the elements of the model 2, did not automate their moves enough, so that affected increase in the amount of energy expenditure.

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