Quantification of the physical activity and physiological constants during hiking in peri-urban recreational areas of Vienna

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Introduction

In the last years, the quantification of physiological parameters during hiking activities has gained increased interest (Saunders et al. 2008). In this communication, we report how the combination of Global Positioning System (GPS), heart rate variability (HRV) and the use of accelerometers leads to a comprehensive description of the hiking activity.

Materials and methods

This work is a pilot study that combines descriptive and quantitative aspects of heterogeneous hiking routes located in peri-urban recreational areas of the City of Vienna, Austria. The main characteristics of the selected routes (distance – km; increase/lose of elevation – m; maximum slope – %; mean slope – %): route 1 (8.2; 353/-349; 22.7; 7.9), route 2 (8.1; 70.4/-71.2; 7.1; 1.6), route 3 (5.4; 411/-409; 50.4; 14.1), route 4 (4.4; 162/-163; 48.7; 7.2).

Four healthy subjects did the hiking routes in alternated days. All of them wore smart t-shirts (Nuubo, Valencia, Spain) equipped with sensors that registered the electrocardiogram, the acceleration in the three axes and the geoposition of the subject as a function of time. The electrocardiography data were processed using the software provided by Nuubo. An analysis of the QRS complex was carried out. The derived parameters of the Heart Rate Variability (HRV) were calculated utilizing the software Kubios HRV (version 2.0, Biosignal Analysis and Medical Imaging Group, Kuopio, Finland). The statistic parameter selected for HRV characterization was pNN50; this parameter expressed the percentage of consecutive RR intervals (i.e. beat-to-beat interval) which at least differ in 50 miliseconds. The energetic consume was obtained using a software developed at the Matlab 2010a interface (Mathworks Inc, Natick, USA). The acceleration of the three axis was used as input and the used equation wa: METs=0.668876+0.000863*counts (Sasaki et al. 2011). The data concerning the geoposition were visualized by Google Earth. The spatial data were expressed by means of the median (range). Due to the small sample number (n=4) non-parametric test were carried out to establish the differences between the variety of routes. In particular, we used the Friedman test. In the cases of significant values we used the T of Wilcoxon to determine such differences. The error was $\alpha<0.05$.

Results

The visual QRS analysis, peak distance of the electrocardiogram signals, did not show any anomalous behavior. Table 1 shows the median of the heart rate per minute (HR) and the pNN50 of the four subjects. The energetic loss can also be observed in Table 1. In particular, the loss for the second route was lower. The mean walking parameter did not show significant differences.

Discussion

Our results show that the route with the smallest slope (route 2) requires less physical effort than the rest of the routes. The slope of the routes is an important factor affecting physical effort (Terrier et al. 2001). Usual route descriptions in recreational areas include information about the distance and the approximate duration that the subject will need to walk along the route. However, we would like to show in this study that routes can be also described with physiological data (e.g. energy consumption). This type of data delivers important information to visitors of outdoor leisure settings. In this way a visitor would be able to chose the hiking path that suits his/her physical capacities as well as his/her leisure preferences.

The main limitation of this type of study is the sample size. In future work, such investigation should be carried out considering the age of the subjects and the physical constitution among other variables.

Conclusion

The physiological parameters considered in this pilot study are sensitive enough to distinguish the physical work caused to the subject by the hiking route. The implementation with physiological parameters of the description of the hiking routes could have interesting implications for the health of the subjects who want to enjoy the natural environment. In addition, a more complete description of the hiking route would increase by itself the tourist value of such recreational area.

Table 1. Physiological and kinetic parameters for each route

	Mean HR (beats/min)	pNN50 (%)	Metabolic Index (METS)	Mean Walking Speed (km/h)
Route 1	100.7(38.7)	26.9(34.61)	5.4(0.8)	3.5(2.1)
Route 2	98.9(30.1)[a]	27.7(27.9)	4.6(0.6)[b]	4.8(1.3)
Route 3	102.1(41.3)	43.6(43.5)	5.5(0.9)	4.9(0.3)
Route 4	106.3(37.7)	26.9(25.7)	5.9(0.9)	5.8(1.1)

The data are expressed in median (range). HR: beats per minute; pNN50: percentage of consecutive RR intervals that differ in more than 50 milliseconds; METS: equivalent metabolic. [a]indicates differences between route 2 and route 1, and between route 2 and route 4 ($p<0.05$). [b] indicates differences between route 2 and the other ones (1, 3 and 4), $p<0.05$.

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