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Original article

STUDY ON HR BEHAVIOUR IN SEDENTARY YOUNG WOMEN USING POLAR HEART RATE MONITORS

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Abstract

Aim. The study aimed to examine both the HR response to exercise during some traditional sports games and the HR variability displayed by two Polar heart rate monitors (a watch and a chest strap), but also to bring to the attention of young people traditional sports games as alternatives during physical education lessons in order to preserve the intangible cultural heritage.

Methods. The research methods used in this paper were: scientific documentation, Paired Samples *t* Test, Wilcoxon Test, statistical mathematics and graphical method.

Results. It can be noticed that the results of measurements obtained with the two devices are significantly different in statistical terms only for maximum HR, where $p = 0.008 < 0.05$ for $t = 3.9$ and 6 degrees of freedom.

Conclusions. The maximum HR values recorded during some traditional games such as Ultimate or Oina have once again revealed the importance of using these devices to monitor heart rate, an important indicator of body adaptation to exercise. The female student participating in this research provided maximum effort for more than 15 out of the 20 minutes allocated to the thematic sequence, which indicated a low level of cardiovascular fitness, therefore she was recommended to do more exercise and opt for aerobic motor activities in her free time.
The statistically processed results have shown that the Polar Vantage V2 Watch has good accuracy during low- and moderate-intensity exercises and can be used with confidence by young people in their leisure motor activities.

Keywords: university students, physical education lesson, heart rate monitor, European traditional sports, Polar Vantage V2 Watch, Polar H10 Chest Strap.

Introduction

Physical activity is known to improve an individual's fitness and therefore physical and mental health, which are essential components for assessing quality of life in modern society, being prerequisites of physical, psychological, spiritual and social wellbeing (Braneț and Bălan, 2021). Human relationships are an important aspect of an individual's social wellbeing, and traditional sports games can be an excellent socialisation tool, especially for the elderly.

Traditional games, which are often played during local events, bring together people from a community regardless of gender, age, ethnicity or social class, and this context ensures better conviviality, harmony and an intercultural mix.

Traditional games involve doing exercise of different intensity levels depending on the characteristics of the games concerned, whose regular practice mainly leads to improved functioning of the musculoskeletal system and obviously to increased functional capabilities of the other body systems.

Human resource monitoring becomes extremely important due to the unique reaction of each individual to a particular type of effort, thus creating the basis for compliance with the principle of individualisation, which is absolutely necessary in physical activities.

HR monitoring, as a crucial indicator of the body adaptation to exercise, is imperative during various physical activities because too much intensity can be detrimental to the health status, especially in the case of sedentary people.

"The electrocardiogram (ECG) and Holter monitoring devices are accurate, but they are not appropriate for use in field settings due to cost, size and complexity of operation." (Laukkanen and Virtanen, 1998)

In this context, the most popular devices used to assess cardiovascular fitness on the sports ground are chest straps and HR monitoring watches. Unlike chest straps, wrist-worn devices (watches) offer extra convenience and comfort.

According to a multitude of studies (Ge, Prasad, Costadopoulos, Alsadoon, Singh, Elchouemi, 2016; Wang, Blackburn, Desai, Phelan, Gillinov, Houghtaling, Gillinov, 2016), electrode-containing chest monitors have the closest accuracy to electrocardiogram (ECG) in displaying HR values

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during exercise compared to other types of similar devices.

However, these devices are limited in detecting heart rate disorders (Boudet and Chaumoux, 2001), being "recommended to healthy public for which they were built" (Etiwy, Akhrass, Gillinov, Alashi, Wang, Blackburn, Gillinov, Phelan, Gillinov, Houg htaling, Javadikasgari, Desai, 2019).

A study conducted by Pasadyn et al. 2017 on a sample of 50 adult athletes reveals the superior accuracy of the Polar H7 Chest Strap compared to other wrist devices (such as Apple Watch III, Fitbit Iconic, Garmin Vivosmart HR and Tom Tom Spark 3) worn during different types of effort.

The superior accuracy of the Polar H7 Chest Strap has also been confirmed in other studies (Gillinov, Etiwy, Wang, Blackburn, Phelan, Gillinov, Houghtaling, Javadikasgari, Desai, 2017; Weippert, Kumar, Kreuzfeld, Arndt, Rieger, Stoll, 2010; Kingsley, Lewis, Marson, 2005) being followed by Apple Watch, Tom Tom Spark 3 and Garmin Forerunner.

"Wrist-worn optical HR monitor (OHRM) could be equivalent and therefore a valid alternative to traditional chest strap during a broad range of activities in a heterogeneous healthy population." (Sartor, Gelissen, van Dinther, Roovers, Papini, Coppola, 2018)

Wrist-worn devices (Fitbit Charge 2 and Garmin Vivosmart HR+) indicated good HR accuracy at low-to-moderate exercise intensities (Reddy, Pooni, Zaharieva, Senf, El Youssef, Dassau, Doyle Iii, Clements, Rickels, Patton, Castle, Riddell, Jacobs, 2018). The Polar Vantage M Watch using the photoplethysmography (PPG) technology (an optical technique that monitors changes in blood volume beneath the skin) also showed a strong correlation with ECG at low-to-moderate exercise intensities (Shumate, Link, Furness, Kemp-Smith, Simas, Climstein, 2021).

Materials and Method

Research Aim

The study aimed to examine both the HR response to exercise during some traditional sports games and the HR variability displayed by two Polar heart rate monitors (a watch and a chest strap), but also to bring to the attention of young people traditional sports games as alternatives during physical education lessons in order to preserve the intangible cultural heritage.

Research Methods

The research methods used in this paper were: scientific documentation, Paired Samples *t* Test, Wilcoxon Test (Predoiu, 2020), statistical mathematics and graphical method.

Participants and Location

The present research is a case study of a healthy female student aged 19 years, and its main purpose is to analyse her HR response during physical education and sport (PES) lessons conducted in May 2022 on the outdoor court within the UPB Complex. The student was informed about the procedures and characteristics of the investigation before the start of the study in which she participated voluntarily, respecting the research conditions and ethical standards.

Research Design

The research took place in May 2022, in the second semester of the academic year, and the student was monitored during the fundamental part of the physical education and sport lessons that included 7 sports out of which 5 were European traditional games (Pétanque, Bocce, Malha, Oina and Bolos Cartageneros).

Before starting the research, both monitors were personalised with the student's data: age, gender, weight, height and type of sports activity.

Using the Polar Team Application, the data collected by the Polar H10 Chest Strap were downloaded to the Apple tablet, and those from the Polar Vantage V2 Watch were downloaded to the phone through the Polar Flow Application.

It should also be mentioned that the participant was asked not to eat two hours before the test, not to drink alcoholic or caffeinated beverages, not to smoke and not to ingest drugs in order to prevent any potential stimulating effects on HR.

Each of the four PES lessons lasted 100 minutes and had the following structure: warm-up for about 35 minutes, followed by a 10-minute break to let the student's HR drop, during which time she was attached the devices used in the research. This was followed by two thematic sequences of the lesson, with a length of 20 minutes each.

In the first thematic sequence of the first lesson, the research participant was a member of the Pétanque team, the traditional game of France, and in the second thematic sequence, she was a member of the Ultimate Frisbee team.

The second PES lesson had the same structure, but in the first thematic sequence, the student played Bocce, the traditional game of Italy, while in the second thematic sequence, she played Catchball, the traditional game of Israel.

The third PES lesson followed the same structure, but in the first thematic sequence, the participant played Malha, the traditional game of Portugal, while in the second thematic sequence, she played Oina in 6, the national sport of Romania.

In the fourth PES lesson, the student was monitored for only one traditional game, namely Bolos Cartageneros, from the Murcia area in Spain.

It should be noted that a 5-minute hydration break was granted between the two thematic sequences, and the last minutes of the lessons were allocated to the cool-down.

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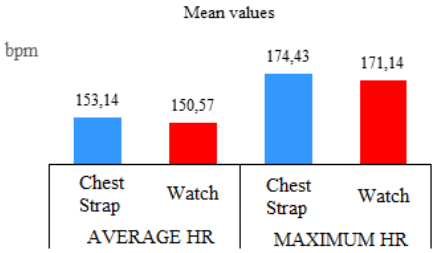
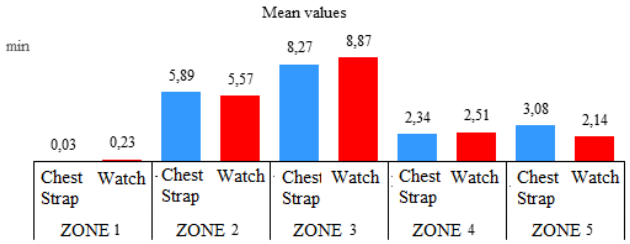
Table 1. Statistical indicators for the Polar H10 Chest Strap vs. Polar Vantage V2 Watch

PARAMETERS		Mean	Std. Deviation	Coefficient of variation
Average HR	Chest Strap	153.14	18.8	12.3%
	Watch	150.57	15.2	10.1%
Maximum HR	Chest Strap	174.43	19.8	11.3%
	Watch	171.14	20.1	11.8%
ZONE 1	Chest Strap	0.03	0.1	186.3%
	Watch	0.23	0.4	190.5%
ZONE 2	Chest Strap	5.89	5.6	94.7%
	Watch	5.57	4.9	87.2%
ZONE 3	Chest Strap	8.27	4.2	51.3%
	Watch	8.87	4.6	52.3%
ZONE 4	Chest Strap	2.34	3.2	134.7%
	Watch	2.51	3.4	135.5%
ZONE 5	Chest Strap	3.08	5.9	191.1%
	Watch	2.14	3.8	179.8%

It is noted that the mean values recorded for the Polar H10 Chest Strap and Polar Vantage V2 Watch devices are relatively close. The coefficients of variation show that the data measured with the two devices are homogeneously dispersed in the case of average HR and maximum HR, with values lower than 15%. In all effort zones, the measurement results are unevenly dispersed, the coefficients of variation having values higher than 30%. Graph 1 shows the means for average HR and maximum HR, and Graph 2 highlights the means for the 5 effort zones.



Graph 1. Mean values of average HR and maximum HR recorded by Polar H10 Chest Strap vs. Polar Vantage V2 Watch



Graph 2. Mean HR values per effort zone recorded by Polar H10 Chest Strap vs. Polar Vantage V2 Watch

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Results and discussion

To compare the average results obtained with the two devices, the Paired Samples *t* Test was used to measure average HR, maximum HR and the 5 effort zones. These results are shown in Table 2.

Table 2. Statistical indicators for the Polar H10 Chest Strap vs. Polar Vantage V2 Watch

Polar Chest Strap vs. Polar Watch		Paired Differences					t	df	p(2-tailed)
		Mean diff.	Std. Deviation	Std. Error Mean	95% Confidence Interval of the difference				
					Lower	Upper			
Average HR	Chest Strap - Watch	2.6	4.8	1.8	-1.9	7.0	1.4	6	0.208
Maximum HR	Chest Strap - Watch	3.3	2.2	0.8	1.2	5.3	3.9	6	**0.008**
ZONE 1	Chest Strap - Watch	-0.2	0.4	0.2	-0.6	0.2	1.4	6	0.222
ZONE 2	Chest Strap - Watch	0.3	0.9	0.3	-0.5	1.2	0.9	6	0.387
ZONE 3	Chest Strap - Watch	-0.6	1.3	0.5	-1.8	0.6	1.2	6	0.276
ZONE 4	Chest Strap – Watch	-0.2	1.7	0.7	-1.8	1.4	0.3	6	0.805
ZONE 5	Chest Strap – Watch	0.9	2.2	0.8	-1.1	2.9	1.2	6	0.292

It can be seen that the measurement results obtained from the two devices are significantly different in statistical terms only for maximum HR, where $p = 0.008 < 0.05$ for $t = 3.9$ and 6 degrees of freedom. For the other parameters, the significance threshold is $p > 0.05$ and therefore the results recorded with the Polar Chest Strap are not significantly different from those recorded with the Polar Vantage V2 Watch. A comparison with the non-parametric Wilcoxon Test shows that the results are similar in the sense that there are significant differences between the mean values recorded with the two devices only for maximum HR ($p = 0.026 < 0.05$). This confirms the correctness of the results obtained with the *t* Test.

Test Statistics[a]

WILCOXON TEST	Average HR	Maximum HR	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5
	Watch - Chest monitors	Watch - Chest monitors	Watch - Chest monitors	Watch - Chest monitors	Watch - Chest monitors	Watch - Chest monitors	Watch - Chest monitors
Z	-1.549[b]	-2.226[b]	-1.826[c]	-.845[b]	-1.352[c]	-.135[c]	-1.342[b]
p(2-tailed)	0.121	**0.026**	0.068	0.398	0.176	0.893	0.180

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks
c. Based on negative ranks

Conclusions

The maximum HR values recorded during some traditional games such as Ultimate or Oina have once again revealed the importance of using these devices to monitor heart rate, an important indicator of body adaptation to exercise. The female student participating in this research provided maximum effort for more than 15 out of the 20 minutes allocated to the thematic sequence, which indicated a low level of cardiovascular fitness, therefore she was recommended to do more exercise and opt for aerobic motor activities in her free time.

The statistically processed results have shown that the Polar Vantage V2 Watch has good accuracy during low- and moderate-intensity exercises and can be used with confidence by young people in their leisure motor activities.

Author Contributions

All authors have equally contributed to this study and should be considered as main authors.

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