Validity of Apple Watch Heart Rate Sensor Compared to Polar H10 Heart Rate Monitor

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Abstract

Introduction: In this day and age, technology is progressing faster than people know how to keep ahead of the advancements. The new era of technology and smartwatches can be a great benefit to healthcare systems around the world. They can be used for weight management, tracking aerobic exercise, and tracking heart rate. However, if smartwatches can be trusted to accurately help people in their everyday lives, then why aren't doctors and trainers incorporating them into their outpatient instructions? Consequently, the purpose of this study is to observe the accuracy of Apple Watches and to assess if they are as reliable as the Polar Heart Monitors that can be found in exercise testing labs. Methods: Nine college-aged males and six females participated in the YMCA cycle submaximal test while wearing both a Polar Heart Rate Monitor (H10) and a series 3 or 4 Apple Watch to compare the accuracy of the Apple Watch device. Heart rate and rating of perceived exertion were taken during each stage of testing. Paired sample t-tests were used to compare the heart rate readings in each stage. Results: There was no statistical difference between the Apple Watch heart rate reading and the Polar Heart Monitor ($p > 0.05$).Discussion: Based on the results regarding heart rate through the different stages of the YMCA submaximal test, it appears as though the Apple Watch is comparable to the chest strap monitor during cycling. Previous research has shown similar findings during exercise on a treadmill, indicating that the chest strap and Apple Watch measured similar heart rate values (Gillinov et al., 2017) . Based on the findings of this study, it appears Apple Watch heart rate technology is comparable to chest strap heart rate monitors during various modes of physical activity.

Introduction

The new era of technology and smartwatches can be a great benefit to healthcare systems around the world. They can be used for weight management, tracking aerobic exercise, and tracking heart rate. Exercise and physical activity have various benefits, some of which can be seen through the measurement of an individual's heart rate. Benefits include longevity of life, improvement in overall health, decreased risk of various diseases and pathologies, increase in energy, elevated mood, increase in muscle mass, and many more. Though research often times includes heart rate as an aspect or a variable of the experiment conducted, it is not always the focus of the experiment, and so the research obtained is not usually tailored towards the specificities of heart rate. With this experiment, heart rate was at the forefront of the research conducted and with that we hope to inform people about heart rate and its effect on the body as well as educate people on the different devices used to extract such information. The purpose of this study is to observe the accuracy of Apple Watches and to assess if they are as reliable as the Polar Heart Monitors while on a cycle ergometer.

Methods

The study was conducted by wearing both types of monitoring devices, a series 3 or 4 Apple Watch and a Polar Heart Monitor, while completing a submaximal test on a Monark Cycle Ergometer. The Polar Heart Monitor was read off of the app, Polar Team, on an iPad. This test did not require a maximal effort, therefore testing was not extremely strenuous to participants in any way. Testing and data collection was in one session, with the participants wearing both an Apple Watch and a Polar Heart Monitor simultaneously. Volunteers performed a submaximal YMCA test; cycling began at 0.5 kg/min in the first stage, upon completion, dependent upon their heart rate, researchers may increase the kilogram resistance by at least 0.5 kg. The pace subjects strived for was 50 rotations per minute. The entire submaximal test consisted of them peddling on the cycle with an Apple Watch on and a Polar Heart Rate Monitor on. Blood pressure was not taken like the usual YMCA cycle ergometer test, we were simply tracking heart rate for this experiment. One of the researchers checked the Apple Watch every minute on the minute to get the reading for heart rate. Data was analyzed through the SPSS program, using the dependent paired t-test. This compared the different data sets collected of the Apple Watch and the Polar Heart Rate Monitor readings at each stage of the submaximal test. It also includes mean and standard deviation to compare the different heart rate monitors as well (Table 2).

Results

Table 1: Paired Samples Statistics for Apple Watch and Polar Heart Monitor

		Mean	N	Std. Dev	Std. Error Mean
Pair 1	Apple 1	98.47	15	16.247	4.195
	Polar 1	98.80	15	15.848	4.092
Pair 2	Apple 2	122.13	15	14.817	3.826
	Polar 2	122.60	15	14.217	3.671
Pair 3	Apple 3	139.87	15	20.209	5.218
	Polar 3	141.20	15	20.203	5.216

Table 2: Paired Samples Tests for Apple Watch and Polar Heart Monitor

		Mean	Std. Dev	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Apple 1-Polar 1	-0.333	3.457	0.893	-2.228	1.581	-0.373	14	.714
Pair 2	Apple 2-Polar 2	-0.467	3.204	0.827	-2.241	1.308	-0.564	14	.582
Pair 3	Apple 3-Polar 3	-1.333	7.108	1.835	-5.270	2.603	-0.727	14	.480

Summary and Conclusion

The results showed no statistical difference between the polar heart rate monitor and the heart rate function on Apple Watches across varying intensities. Each device read results differently, with the Apple Watch placed on the wrist and using photoplethysmography to pick up the heart rate of the volunteers (Dooley et al. 2017). The technology inside of the Polar Heart Rate monitors detect the electrical activity of the heart throughout each beat and convey the real time data to the Polar Team application (Mohapatra et al 2017). The heart rates became less accurate as stages intensified for the Apple Watch but showed no true statistical difference. The Polar Heart Monitor is strapped to the chest, but the Apple Watch is located on the wrist where it is subject to rougher motions and therefore leads to more difficult readings of blood flow. When both the Apple Watch and the Polar Heart Rate Monitor are properly positioned and secured, the Polar Monitor is less subject to motion. Heart rate differences between the Polar Monitor and the Apple Watch were similar across the three stages with a difference of .333 of a beat at the end of stage one and differed 1.333 beats at the end of stage three but did not vary enough to be statistically significant. Using the Monark cycle ergometer to run a YMCA cycle test allowed easy comparison between the Polar monitor and Apple watch since most participants were able to complete the YMCA protocol to completion allowing three different stages of data collection. The results also showed through the different stages of the YMCA submaximal test, the various factors such as RPE, gender, age, weight, and height have no statistical impact on heart rate.

References

Cheatham. (2018). Assessment of Cardiovascular/ Aerobic Fitness from Submaximal Exercise Tests. Retrieved from https://pdfs.semanticscholar.org/presentation/8a63/3332abfafa93c9f7f540d29757667af72E92.pdf

Dooley, E. E., et al., "Estimating Accuracy at Exercise Intensities: A Comparative Study of Self-Monitoring and Physical Activity Wearable Devices.," *JMIR Mhealth Uhealth.*(2017): 5(3) e34.

El-Amrawy, F., & Nounou, M. (2015). Are Currently Available Wearable Devices for Activity Tracking and Heart Rate Monitoring Accurate, Precise, and Medically Beneficial?. *Healthcare Informatics Research*, *21*(4), 315. doi: 10.4258/hir.2015.21.4.315

Gillinov, S., et al., "Variable Accuracy of Wearable Heart Rate Monitors during Aerobic Exercise.," *Medicine and Science in Sports and Exercise*. (2017): 49(8) 1697-1703.

Martin, T., Jovanov, E., & Raskovic, D. Issues in wearable computing for medical monitoring
applications: a case study of a wearable ECG monitoring device. *Digest Of Papers. Fourth International Symposium On Wearable Computers*. doi: 10.1109/iswc.2000.888463

Mohapatra, P., Preejith, S. P., & Sivaprakasam, M. (2017). A novel sensor for wrist based optical
heart rate monitor. *2017 IEEE International Instrumentation and Measurement Technology Conference (I2MTC)*. doi:10.1109/i2mtc.2017.7969842

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