Pulse Oximetry/Samsung Health: Measuring heart rate using simple mobile applications.

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**Abstract**

Heart rate can be explained as the number of times a person’s heart beats in a minute and is measured in BPM. It can be measured by different apps and biomedical instrumentsand from all our options we chose the pulse oximeter and an app called Samsung health also known as S Health. Pulse oximeter can also help find the oxygen level of a person along with the heart rate and is usually put on the finger. These two methods are easy to use and accessible and that is why people use them on daily basis. We used them both on 4 test subjects, 3 times each, and compared their results to wrist check results, so we can see how accurate the device can be. In the end we based on the accuracy we chose which device was recommendable.

**Keywords used**

Heart rate (HR), beats per minute (BPM), pulse oximetry, pulse check, wrist check, accuracy, precision, standard deviation.

A hand holding a cellphone

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*Figure (1) -pulse oximeter and how it should be placed on finger.*

A close up of a device

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*Figure (2) Samsung health app reading and the different aspects it works on.*



*figure (3) the right place to apply wrist check*

**Introduction**

***Background and significance***

The normal resting heart rate for adults’ rages form 60-100BPM. Generally, the lower your heart rate the more efficient your heart functions and better cardiovascular fitness. Resting heart rate is when the heart is pumping the lowest amount of blood because body is at rest. Maximum heart rate is age related number of BPM of the heart working at maximum

Knowing heartrate is important in many ways such as; while you are exercising and want to check if your workout is intense enough or not, to check if stress management techniques are working for you or not, people with heart problems can monitor their heart rate to know if their heart rate is related to certain symptoms

For this experiment we used pulse oximeter, wrist check and Samsung health app

The pulse oximeter (*figure 1)* was originally introduced in 1935 by a German physician called Karl Matthes who developed the first two wavelength ear Oxygen saturation meter. His idea got more modern and reliable as the years went by, like addition of the signal Extraction Technology that came with a new algorithm to reduce some false alarms during motion.

To get its readings, it is placed on a thin part of the patient’s body, usually a fingertip or earlobe, or foot (for babies). The device passes two wavelengths of light through the body part to a photodetector. It measures the changing absorbance at each of the wavelengths and gives it out based on the pulsing arterial blood. The amount of light that is transmitted (in other words, that is not absorbed) is measured, and separate normalized signals are produced for each wavelength. These signals fluctuate in time because the amount of arterial blood that is present increases (literally pulses) with each heartbeat. By subtracting the minimum transmitted light from the transmitted light in each wavelength, the effects of other tissues are corrected for, generating a continuous signal for pulsatile arterial blood.

**Pros of pulse oximeter**

Monitors oxygen saturation

Easy and affordable

Pain free and convenient

Helps keep track of normal body function

Can be repeatedly used without any problem

**Cons of pulse oximeter**

Skin pigmentation

Nail polish

Motion artifact

Cold temperature

It doesn’t know how to differentiate O2 from CO

**Samsung health app**

The app (*figure 2)* was launched on 2 July 2012, with the new Samsung smartphone, the Galaxy S3 and was installed by default only on some smartphones of the brand. since then serves to track various aspects of daily life such as physical activity, diet, and sleep

* How it works: It measures your heart rate in Beats per Minute using an optical LED light source sensor that shines through your skin, then measures the amount of light that reflects. Reflected light will vary as blood passes under your skin past the light then output as heartbeat.

**Pros of Samsung health app**

* Free and comes with latest Samsung smart phones
* Convenience of having it on your phone
* Comes with other features such as stress, anxiety measures

**Cons of Samsung health app**

* Takes about 15 sec with no motion to gather data
* The app has inaccurate value for cold hands
* It doesn’t work well for people with high melanin concentration.

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*Figure (4) shows where you put your finger to get your heart rate reading*

**Methods**

In this group project we used three different methods to perform our experiments on different people. To check how effective the app is we must compare it with a standard (100% accurate) which is why we performed a wrist check. What we did to check our pulse on the wrist was placing your fingers between the bone and tendon over the radial artery which is located on the side of the wrist.

After finding the values we compared it with true value and standard deviation. Although there were many factors affecting heart rate, we chose to work on body position and reflex action. Under body position there are 4 experiments which are; sitting, standing, jogging and running

What we first did for our body position experiment was to determine which positions we needed to focus on and concluded to choose sitting, standing, jogging and running. And we chose 4 people to work out experiment on (both women and men). Our second step was to make sure everyone taking part in the experiment is well rested (calmly sitting down without any movement for 5 minutes). Once we made sure of that we started our **(experiment 1)** which was sitting down. We measured their heartrates three consecutive times and averaged the values for every single person (to make it accurate). also, for standing up **(experiment 2)** we made sure no external factor is affecting them and that they were breathing at a steady speed. For jogging and running **(experiment 3 and experiment 4)** our aim was to make the speed for all four people the same, so we made them go on a treadmill (for jogging 3.0mph and for running 4.3mph was the speed we used). And for both cases we made sure that all of them were breathing steady and gently before going on the treadmill. And at the end what we found out was the following.

A picture containing sky

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*Figure (5) the data we found for running*

A picture containing writing implement, stationary, pencil

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*Figure (6) data we found for jogging*

The other thing we worked on was reflex action **(factor2)**. We first made sure no external factors were affecting these people and made sure they were breathing steady and calmly. then we found a video that would scare the people and so get their reflex to act in response. The women had a higher heart rate than the men and this is the data we found

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Another thing we checked was how the skin pigment can affect the value of Samsung health app reading and we came to an understanding that the darker the skin the less accurate the reading was.

**Analysis**

From the 3 consecutive data collection from everyone on **experiment 2** this was the average value we got

|  |  |  |  |
| --- | --- | --- | --- |
| No of people | Pulse oximeter | Samsung health | Wrist check |
| Person 1 | 86 | 86 | 84 |
| Person 2 | 88 | 88 | 85 |
| Person 3 | 87 | 87 | 82 |
| Person 4 | 84 | 84 | 80 |

*Table (1) mean value for experiment 2*

**Further analysis on pulse oximeter**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
| No of people | accuracy | precision | Standard deviation | error |
| Person 1 | 98% | 96% | 4% | 2.6 |
| Person 2 | 100% | 96% | 4.6% | 2.6 |
| Person 3 | 99% | 97% | 3.5% | 0% |
| Person 4 | 98% | 98% | 2% | 2.5% |

Samsung health app

|  |  |  |  |
| --- | --- | --- | --- |
| accuracy | precision | Standard deviation | Error |
| 98% | 95% | 5.2 | 3.1 |
| 97% | 95% | 5 | 2.9 |
| 95% | 96% | 3.4 | 2.5 |
| 96% | 97% | 2.3 | 1.2 |

* Wrist check is a 100% accurate and precise

**How we calculated**

Error=\*100

Relative standard deviation=

Standard deviation=

Recommendation and conclusion

* To conclude, The results obtained from series of experiments on people in different conditions shows that there is not much of a difference in the measure of heart beat per minute for either the app and the oximeter though the result obtained from the pulse oximeter is closer to the true values (as obtained from wrist count).
* After weighing in the pros and cons, considering the results obtained from the experiments, it can be concluded that though the Samsung Health app can be considered a reliable, precise and an accurate source for regular monitoring of pulse, a pulse oximeter would be a better recommendation for day to day personal use or healthcare due to the biomedical engineering principles it uses.

***The p-value and t-value:***

|  |  |  |
| --- | --- | --- |
|  | Pulse oximeter | Samsung health |
| t-value | 0.135 | 0.326 |
| p-value | 0.953 | 0.939 |

The t-value is calculated using the formula below:

|  |  |
| --- | --- |
| Picture | Where:   * x**1** is the mean of sample 1 * s**1** is the standard deviation of sample 1 * n**1** is the sample size of sample 1 * x**2** is the mean of sample 2 * s**2** is the standard deviation of sample 2 * n**2** is the sample size in sample 2 |

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