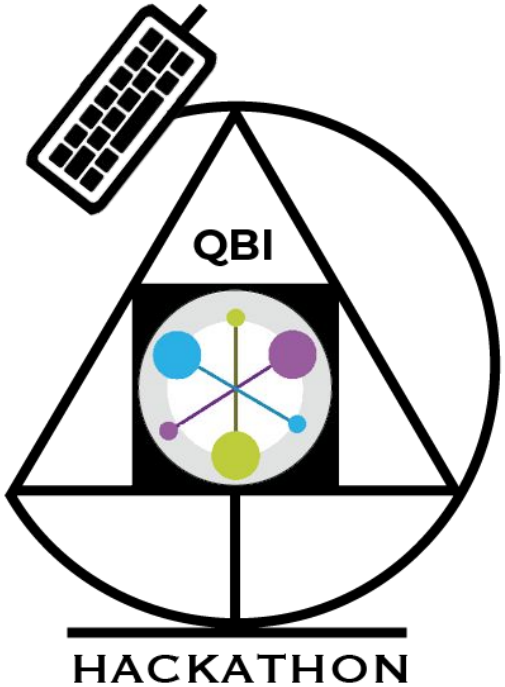
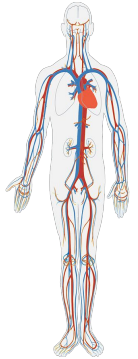
QBI Sleep



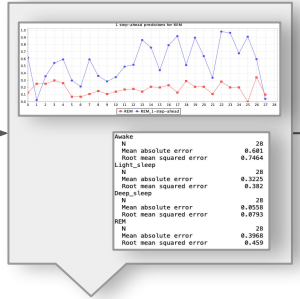
QBI Sleep App



Recording devices:

1. **Body mobility**
2. **Sound**
3. **EEG**
4. **ECG**
5. **Blood Oxygen level**
6. **...**

Sleeping recording app
Rapid eye movement (REM)



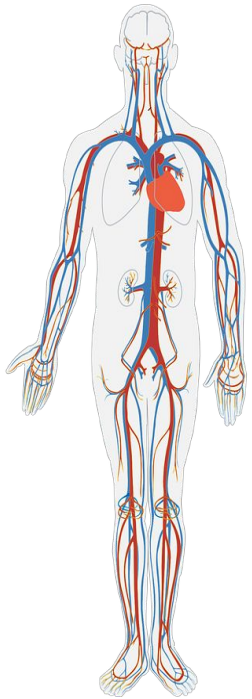
Personalized Sleep Suggestions

Source: Apple Health Monitoring Watch Data

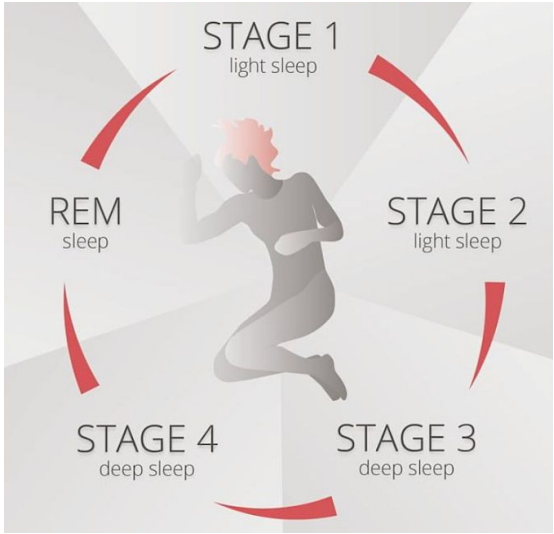
Further applications for therapeutic treatments relating to sleep disorders:

Sleep Apnea, Nightmares, Depression, and Insomnia

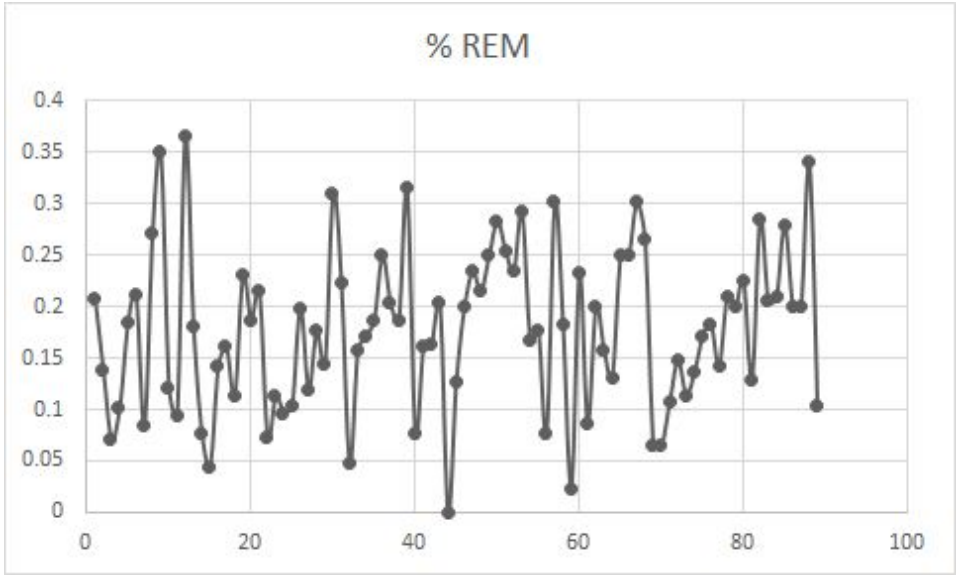
Profile Measurements of Sleep



FACTOR	MEAN
REM	98 min
Deep Sleep	147 min
Light Sleep	196 min
Sleep Lag	49 min
Oxygen Consumption	84 mL02/kg/
Heart REM	65 b/p/m
Sleep Cycle Duration	122 min



Each complete sleep cycle lasts approximately 122 minutes.



- **Rapid eye movement** (REM) is the stage of sleep characterized by **rapid** saccadic **movements** of the **eyes**.
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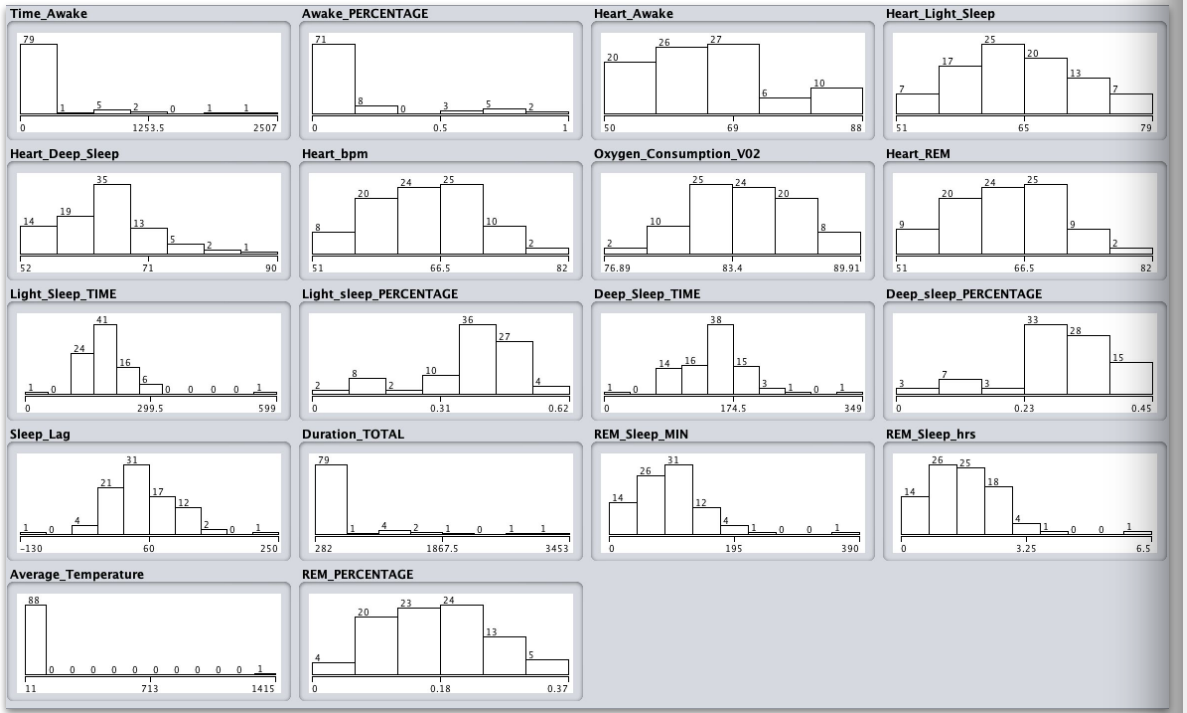
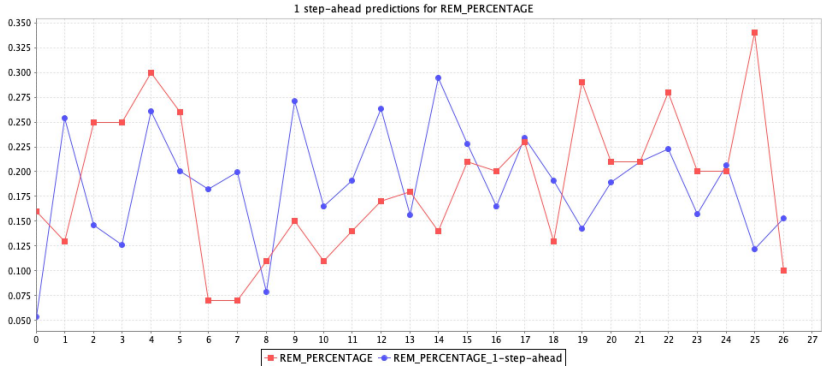
- During this stage, the activity of the brain's neurons is quite similar to that during waking hours.
-
- Most of the vividly recalled dreams occur during REM sleep.



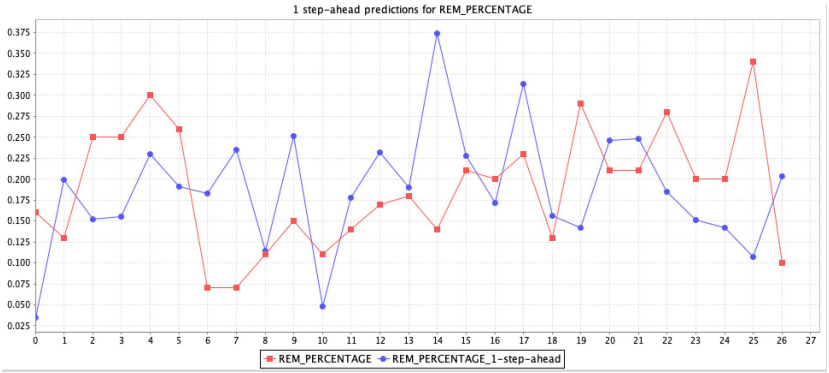
- Time_AwakeAwake_PERCETAGE
- Heart_AwakeHeart
- Ligt_SleepHeart
- Deep_Sleep
- Heart_bpm
- Oxygen_Consumption_V02
- Heart_REM
- Light_Sleep_TIME
- Light_sleep_PERCENTAGED
- Deep_sleep_PERCENTAGE
- Sleep_Lag
- Duration_TOTAL
- REM_Sleep_MIN
- REM_Sleep_hrsAverage_
- Temperature
- Walking_Steps
- Sleep_cycle_duration

- **REM_PERCENTAGE**



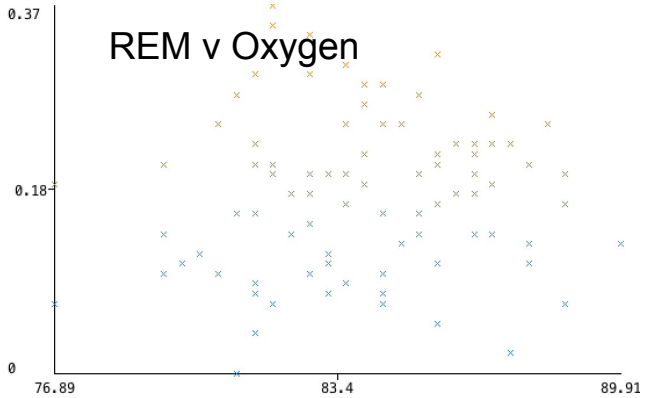
REM_PERCENTAGE

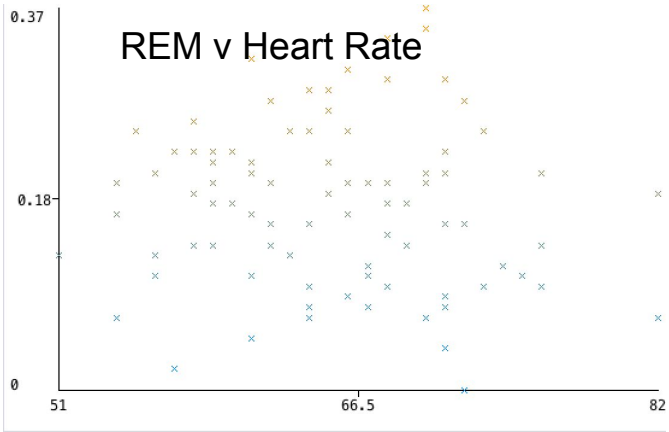
Mean absolute error	0.0827
Root mean squared error	0.1012

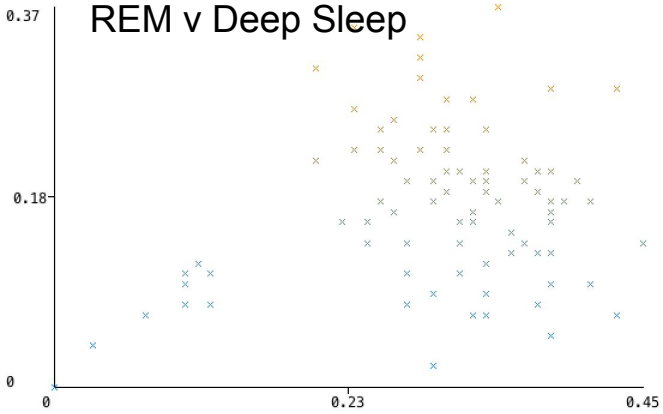


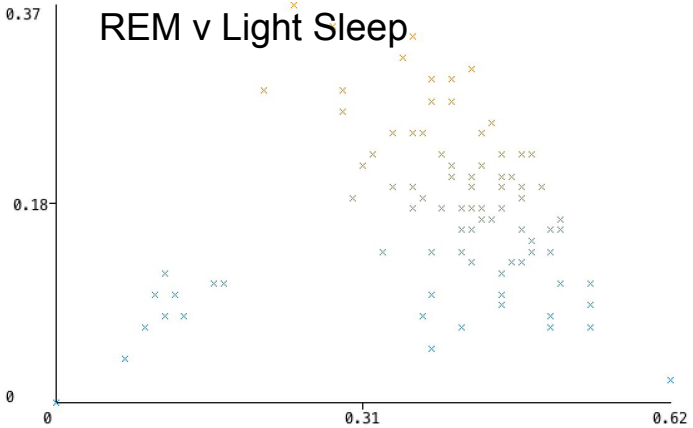
REM_PERCENTAGE

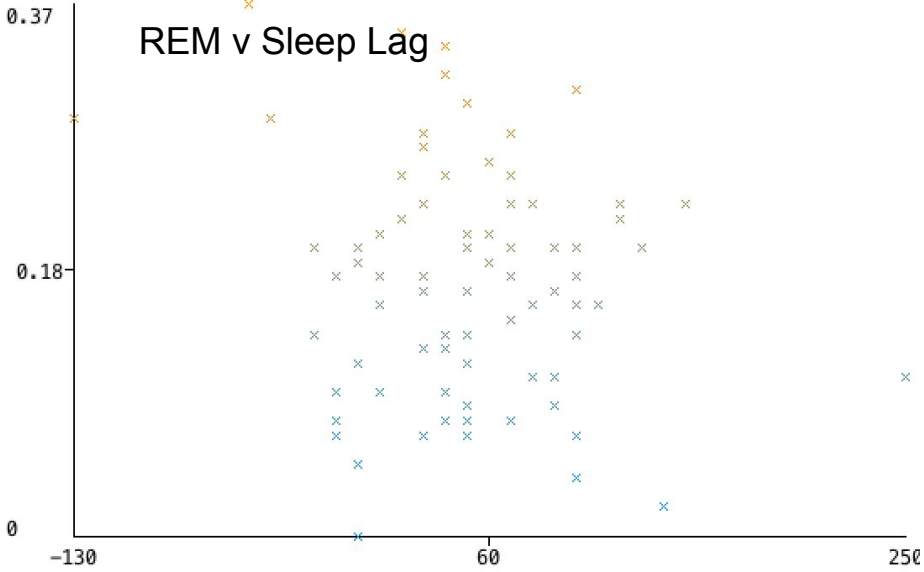
Mean absolute error	0.0738
Root mean squared error	0.0912


REM v Oxygen
0.37
0.18
0
76.89
83.4
89.91


REM v Heart Rate
0.37
0.18
0
51
66.5
82


REM v Deep Sleep
0.37
0.18
0
0
0.23
0.45


REM v Light Sleep
0.37
0.18
0
0
0.31
0.62


REM v Sleep Lag
0.37
0.18
0
-130
60
250

How can we improve sleep?

Without using medication it is possible to directly improve the quality of sleep.

This can be applied through digital health recommendations.

1. We have tested important factors that are directly related to REM (sleep quality).
2. We are able to predict the strengths of REM based on any subset of these parameters.
3. We have high accuracy

The amount of time an individual spends in each sleep cycle is important for unders

LINEAR REGRESSION

This method is based on relationship between a scalar dependent variable *y* and one or more explanatory variables denoted *x*. It allows the comparison of dichotomous, categorical and continuous predictors with a continuous outcome. Linear regression tries to find the best curve to fit the data. Linear regression is finding the best curve is least squares, which minimizes the sum of the distance from the line for each of points. The actual observations, y_i , may be slightly off the population line because of variability in the population.

$$y_i = \beta_0 + \beta_1 x_{i1} + \cdots + \beta_p x_{ip} + \varepsilon_i = \mathbf{x}_i^{\mathsf{T}} \boldsymbol{\beta} + \varepsilon_i, \qquad i = 1, \ldots, n,$$