LifeQ®

Heart Health Score

February 2021

How is the LifeQ Heart Health Score validated?

As no gold-standard exists for benchmarking the LifeQ Heart Health Score(HHS) score, LifeQ has used the Framingham Risk Score (FRS) to assess the value of HHS as a proxy for long term cardiovascular mortality risk.

The FRS is widely accepted as a clinical measure and is used by both physicians and the life insurance industry to assess the 10 year cardiovascular risk of an individual. The Framingham score is calculated from various risk factors, including: age, cholesterol, blood pressure, diabetes and smoker status.

What testing Protocol does LifeQ follow?

Two separate data collections were undertaken by LifeQ and used to validate the use of the HHS model as a predictor of cardiovascular mortality risk.

Table 1: **Detailed information on the gender of the cohort used for validation**

BMI bins	Number of Participants	Male	Female
Cohort 1	843	465	378
Cohort 2	215	122	93

For validation purposes, the LifeQ Heart Health Score output was compared to an aggregate of the risk factors used in the Framingham Risk Score (from here on referred to as the Framingham Risk Aggregate) calculated from biometrics and questionnaire responses of pilot participants. For each data-collection, the subjects wore the device continuously for between 45 and 90 days.

Accuracy

Before the normalization for age and gender and the scaling to a score between 0-100 is done, the LifeQ Heart Health Score can be seen as an estimate of the Framingham Risk Aggregate.

Table1 and Figure 1 below show statistics for the comparison between the unnormalised HHS and the Framingham Risk Aggregate on the two cohorts.

Table 1. Goodness of Fit statistics for the unnormalised HHS vs the Framingham Risk Aggregate.

	Sample Size (Number of Subjects)	Mean Absolute Deviation	Pearson Correlation
Cohort 1: Male	465	0.746	0.702
Cohort 1: Female	378	0.661	0.709
Cohort 2: Male	122	0.812	0.725

Cohort 2: Female	93	0.801	0.766

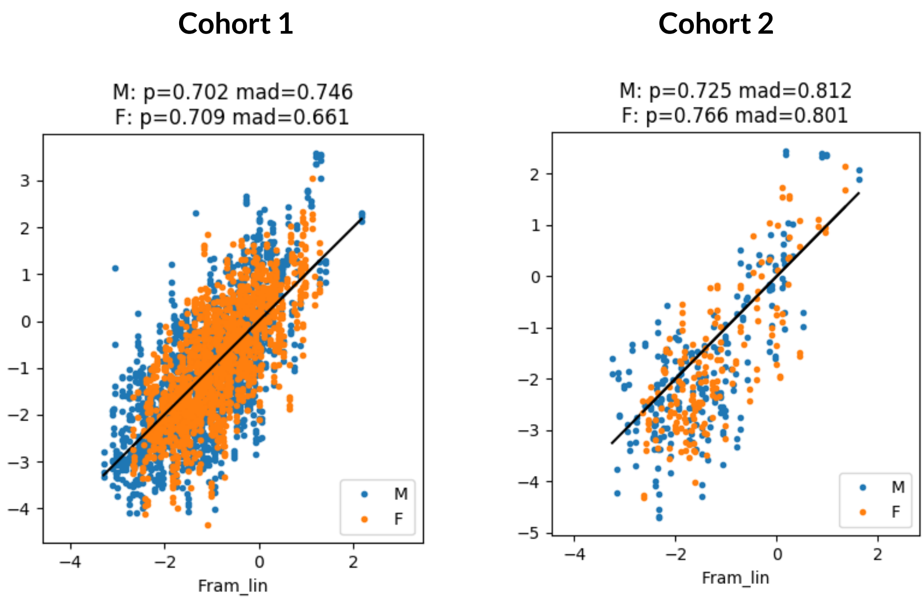

Figure 1: HHS Model vs Reference log-hazard . The x-axis represents the LifeQ unnormalised score. The y-axis represents the Framingham Risk Aggregate

The comparison of the unnormalized LifeQ Heart Health Score output distribution to the Framingham Risk Aggregate can be seen in Figure 2 below:

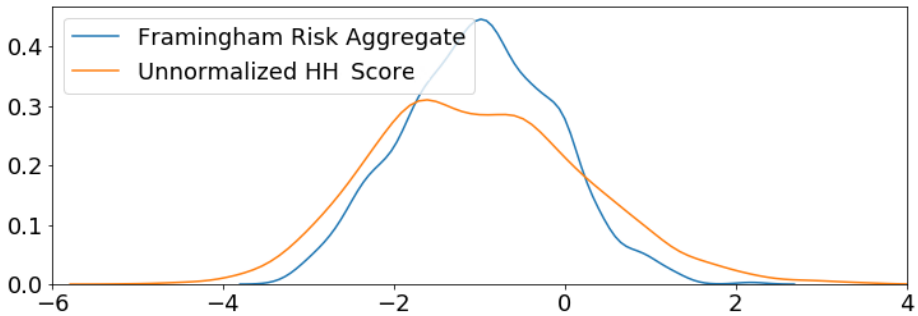

Figure 2: Comparison of the distribution of the unnormalized Heart Health Score output and the Framingham Risk Aggregate.

The scatter plot in Figure 3 below compares the unnormalized LifeQ Heart Health Score output and the Framingham Risk Aggregate, indicating a correlation of 0.718.

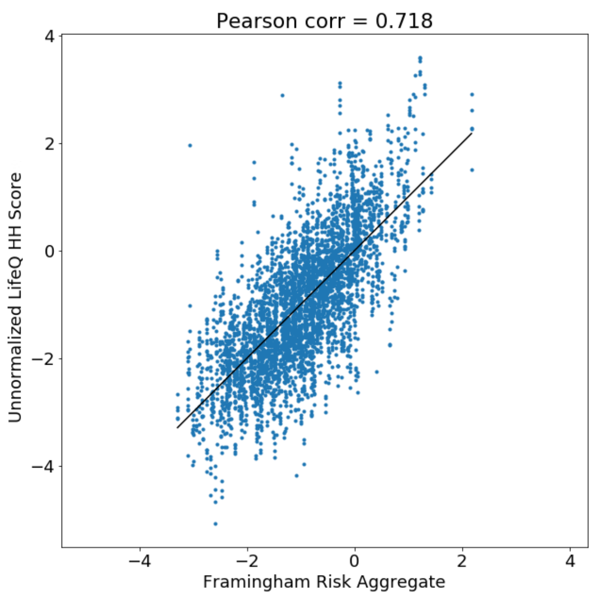

Figure 3 Correlation between the unnormalized Heart Health Score output and the Framingham Risk Aggregate.

Figure 4 below demonstrates the strong correlation of the Framingham Risk Aggregate with age, where the distribution of the Framingham Risk Aggregate is stratified according to age groups.

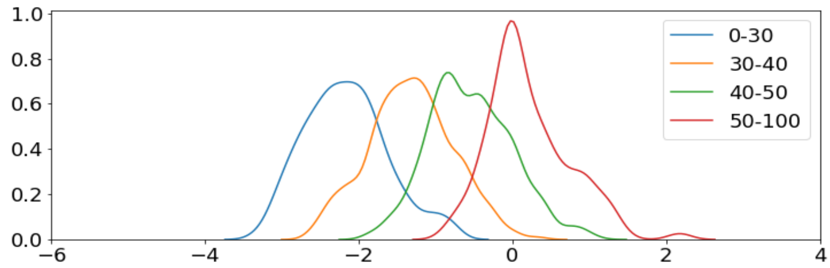

Figure 4 Distribution of the Framingham Risk Aggregate stratified according to age.

Figure 5 illustrates that the unnormalized LifeQ Heart Health Score output follows the same pattern when stratified according to age. The distribution shifts toward higher risk for older individuals.

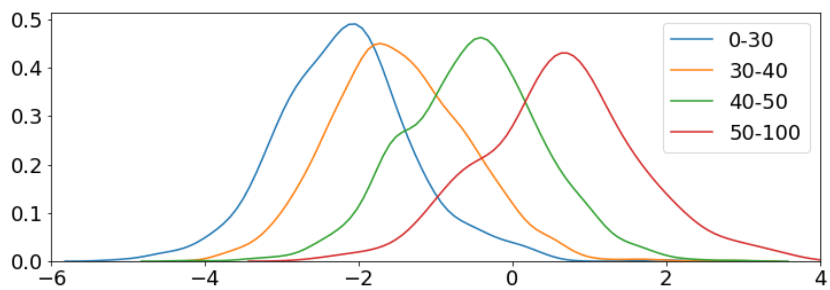

Figure 5 Distribution of the unnormalized LifeQ Heart Health Score output stratified according to age.

Figure 6 below shows bucketed results by age and gender. In each panel, the left-hand column represents the LifeQ HHS model outputs and the right-hand column represents the reference (Framingham) . Both the reference score and the model output have been bucketed into "high" (red) , “moderate”(amber) and “low”(green) risk classes. As expected, risk increases with age and there is good agreement in this trend between the model and the reference.

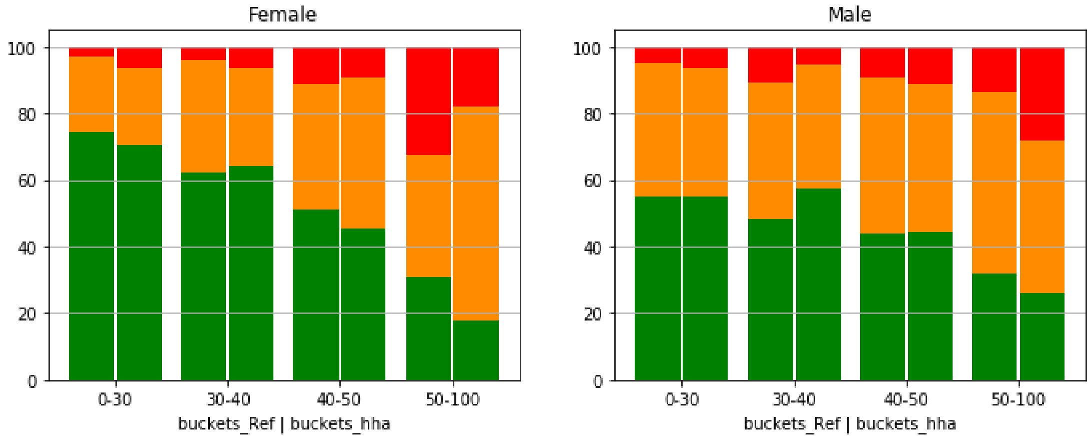

Figure 6: Bucketed unnormalized HHS score results by age and gender.

The value of a Heart Health Score for use in a health management solution is not only to identify those users with immediate cardiovascular risk, but also to understand which users across the age spectrum could be on a faster trajectory to poor health. For this reason, LifeQ normalizes the HHS output with respect to age- and gender- specific healthy norms.

Figure 7 below shows the resulting distributions of the final normalized LifeQ Heart Health Score output corresponding to specific age groups. The difference across age groups that can still be observed can be attributed to the relatively small sample sizes within certain age brackets—the implication being that the older group in the sample data were relatively unhealthy compared to age norms.

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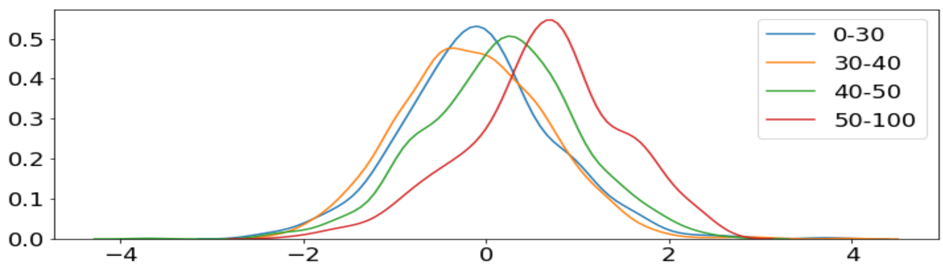

Figure 7 Distribution of the normalized (age- and sex) LifeQ Heart Health Score output stratified according to age

Figure 8 below shows the resulting distributions of the final normalized LifeQ Heart Health Score when compared to the expected distribution of a general population cohort. Given the LifeQ data collection studies were conducted with relatively healthy, working populations, the

LifeQ cohort as expected produced a slightly healthier distribution than a general population cohort.

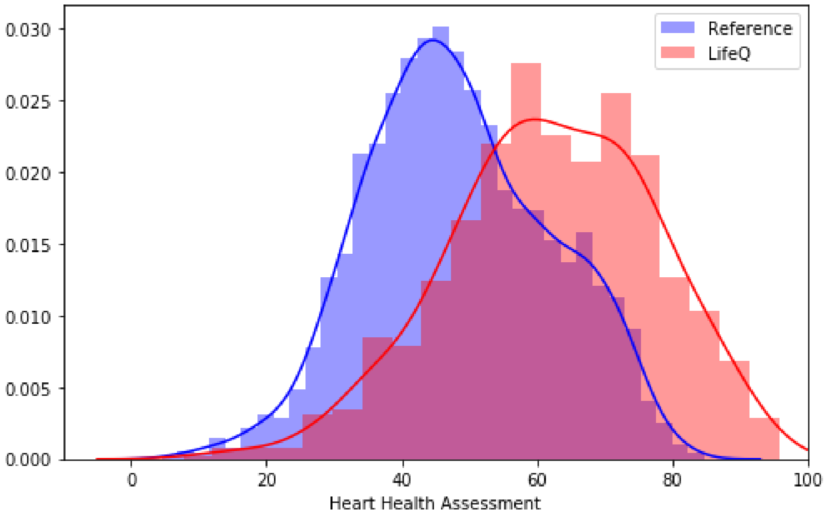

Figure 8: Distribution of the final HHS score.

Constraints in developing an accurate Heart Health Score

Measuring HR, HRV and Pulse Waveform from a wrist-based device is complex and the technology has limitations owing to the nature of the available signal.

In addition to requiring accurate HR data, the LifeQ HHS requires at least 7 (non-consecutive) days of data within a 31- day period to output a HHS score. Many of the key inputs are recorded during sleep, and for this reason sleep must be included in the minimum requirement of 7 days as well as any additional days that are to contribute to the HHS score.

The HHS has not been validated for individuals younger than 18 or over 70 and should not be used to diagnose cardiovascular disease or to classify users as ill. The purpose of the HHS score is to provide users with a guide of how their heart health compares with other people of a similar age and gender. LifeQ recommends that users seek professional advice if they are concerned about their HHS score.