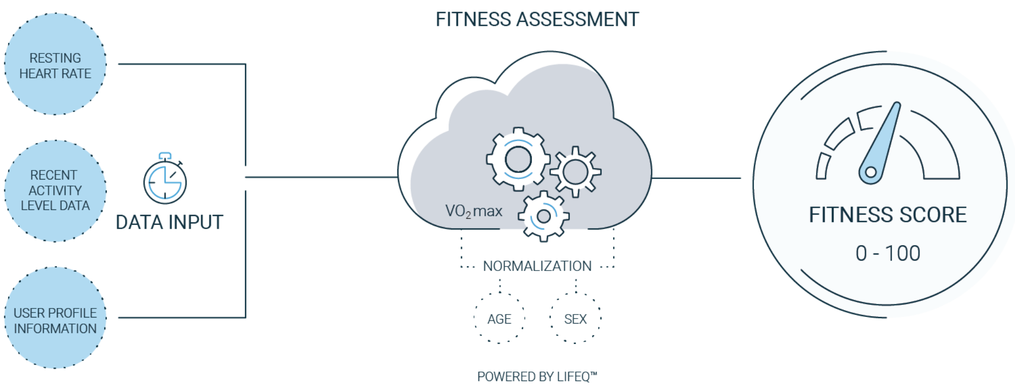
Fitness Health Score

What is the LifeQ Fitness Health Score?

The LifeQ Fitness Health Score (FHS) evaluates the fitness status of an individual, and is provided as a score from 0 - 100. This fitness score can be interpreted as an individual's long term, all cause mortality risk relative to people of the same age and gender.

VO_2max is regarded as the Gold Standard for measuring cardiovascular fitness and aerobic endurance and is a well known and validated independent predictor of all-cause mortality. The LifeQ FHS allows an individual to understand how their fitness level relates to their risk of developing health complications, when compared to a similar population.

The LifeQ solution uses the **LifeQ Lifestyle VO_2max** as input to developing the Fitness Health Score.



What FHS Outputs are provided by LifeQ?

The LifeQ FHS solution outputs a value 0-100 which has been normalised for age and gender.

The table below provides guidance on how to interpret the FHS score providing an estimate of the percentage of the population that should fall in each category.

Table 1: Categorization of scores for Heart Health Score

Health performance	Score range	Percentage of test population within this range
Very poor	0 - 24	~ 10
Below average	25 - 39	~ 20
Average	40 - 59	~ 40
Above average	60 - 74	~ 20
Excellent	75 - 100	~ 10

The all-cause mortality risk (hazard ratio) relative to a score of 50 halves for every 115-point increment.

As the FHS is an indicator of long-term risk, it is not expected to change from day to day. The score has been designed as a rolling 31 day average in order to smooth the score out and remove any anomalies that may cause sudden fluctuations. For this reason, it may take a user several months of sustained hard work to see an improvement in their fitness score.

Accuracy

The LifeQ Fitness Health Score was developed on data collected from LifeQ pilot cohorts, along with peer-reviewed scientific literature that investigated multiple large (>10 000 participants) cohorts. This section presents some of the findings on how the score performs based on normative ranges found in literature.

Distribution of VO_2 max estimates

The density plot[1] in Figure 1 below shows the distribution of VO_2 max estimates, derived from two LifeQ pilot datasets totaling in excess of 1 000 participants. The data clearly portrays naturally higher VO_2 max values for males at population level, which corresponds to normative ranges.

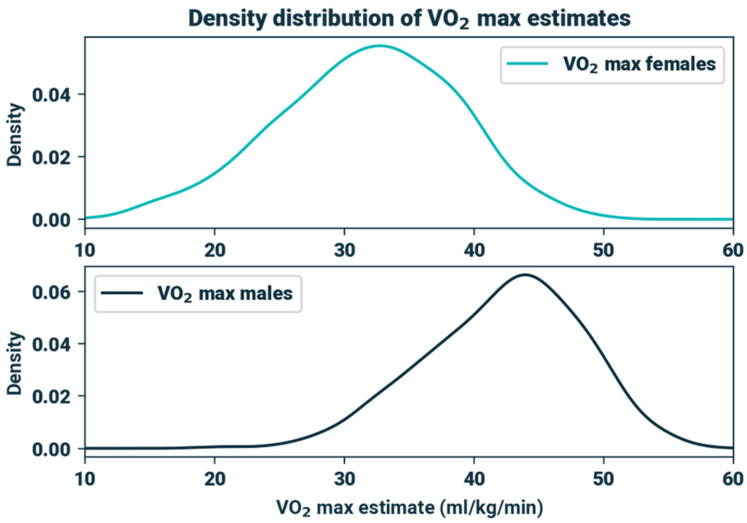


Figure 1. The distribution of VO_2 max estimates for both female and male pilot participants

Figure 2 represents the distribution of VO_2 max estimates across all pilot participants (both male and female). As expected, the bell curve indicates that the majority of the participants fall in the middle ranges (between 30 and 50 ml/kg/min), with the minority of participants falling in the lowest or highest ranges.

[1] A density plot shows a continuous distribution with the peaks indicating where values are concentrated over the dataset in question.

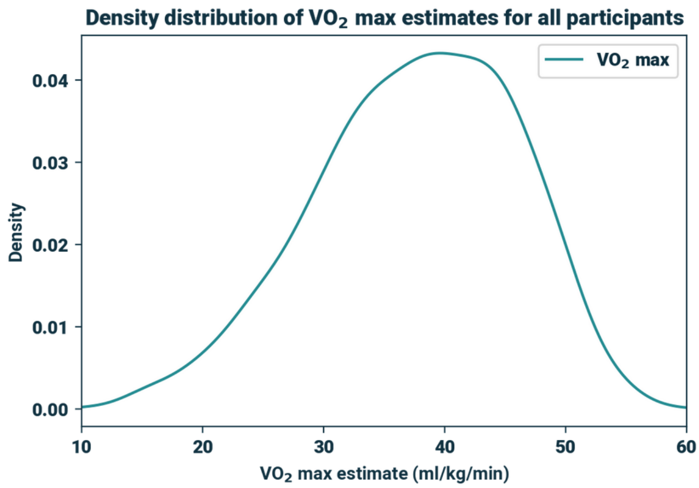


Figure 2. The VO_2 max distributions for all participants

Normalized results

VO_2 max can differ substantially depending on fitness levels and will be further impacted by gender and age. To contextualize an individual's VO_2 max (their fitness level) in comparison to their peer group, one needs to perform a normalized comparison. In Figure 3, the VO_2 max estimates, gathered from the same two datasets as mentioned above, are binned into categories that correspond to normative VO_2 max ranges for age and gender[2] classified from "very poor" to "excellent".

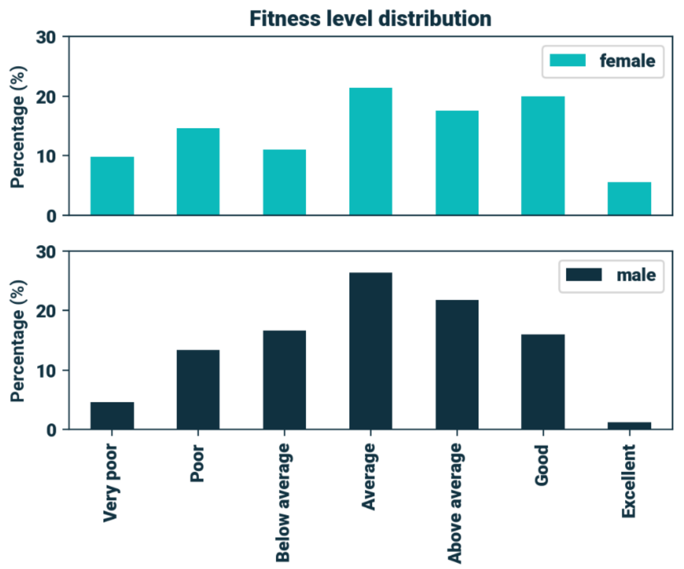


Figure 3. Distribution of fitness levels for females and males, which corresponds to normative VO_2 max ranges for sex

The seven fitness level categories seen above are then scaled to produce a fitness score from 0 - 100 (worst observed to best observed). This score provides a quantified view of an individual's fitness, relative to other individuals of the same age and gender.

[2] Please note that, while age was factored in during normalization, only the ranges for sex are displayed in Figure 21.

Risk classification

Research has shown that cardiorespiratory fitness is inversely associated with long-term mortality (i.e., the fitter you are, the longer you are likely to live) and there is no upper limit to the benefits observed. As mentioned earlier, the LifeQ FitnessScore has been engineered to precisely reflect literature-derived VO_2 max algorithms, which means that the findings from follow-up studies of these algorithms directly apply to the LifeQ Fitness Score outputs.

Stamatakis et al, for example, performed a mortality rate analysis on the 32 319 subjects who took part in eight English and Scottish health survey studies between 1994 and 2003. Participants were tracked over an average of 9 (+-3.6) years and the analysis compared the same VO_2 max algorithm harnessed by LifeQ to the observed mortality rates.

The study established hazard ratios[3] for five fitness categories (where 1 - 5 represents lowest to highest fitness scores). Figure 4 illustrates how, over and above other effects, such as BMI, blood pressure, cholesterol, smoker status, etc., fitness further contributes to an individual's risk; especially where an individual already has a high mortality risk (categories 1 and 2).

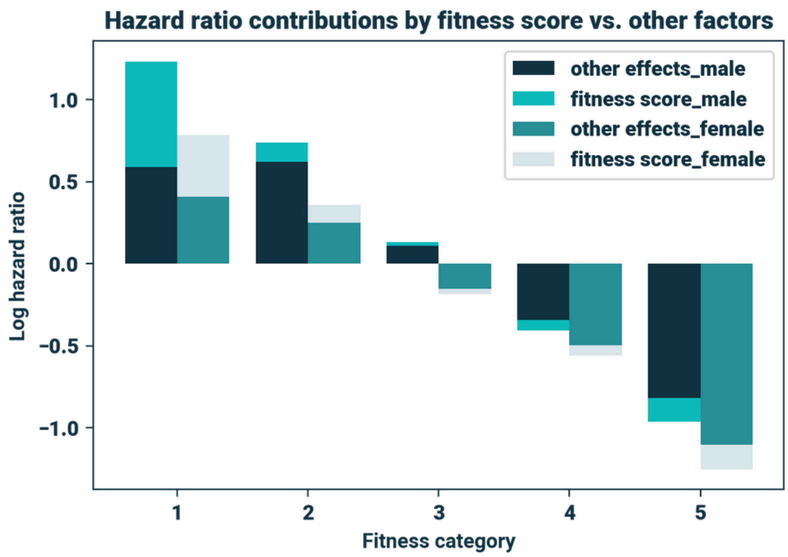


Figure 4. Comparison of the contribution of fitness score vs. other effects to hazard ratios in the Stamatakis et al analysis

From the same research by Stamatakis et al, Figure 5 portrays fitness score-derived hazard ratios against VO_2 max estimates. The graph illustrates that the higher the VO_2 max, the lower the hazard ratio is. In other words, the fitter an individual is the lower their mortality risk will be.

[3] Hazard ratios indicate relative risk, e.g., if a hazard ratio is 0.5, then the relative risk of dying in one group is half the risk of dying in another group. A hazard ratio of 0.85 means that a 1 standard deviation (SD) improvement in model-derived VO_2 max represents a 15% reduction in risk. To summarize, the lower the hazard ratio is, the lower an individual's risk of dying is relative to other groups.

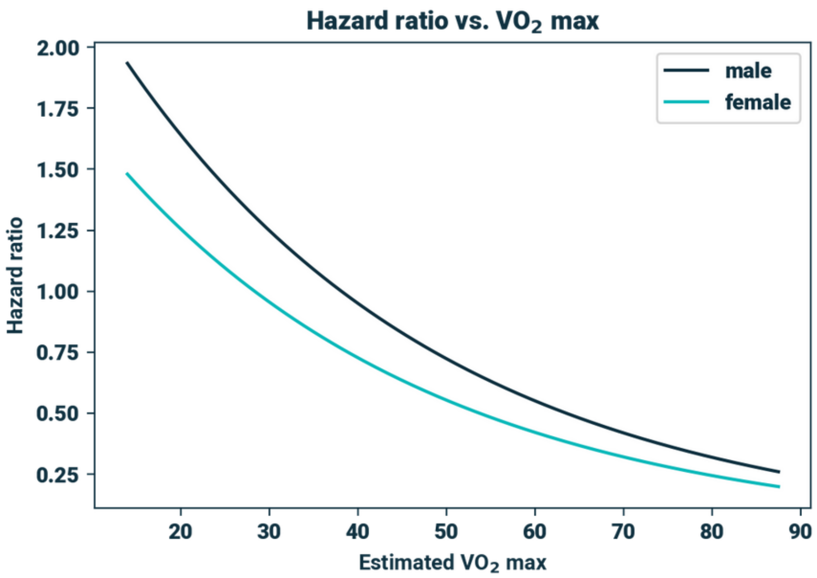


Figure 5. Estimated hazard ratios based on fitness score plotted against the VO_2 max estimates Note that these hazard ratios are adjusted for (and hence present information over and above) all other effects, including smoking, age, hypertension, etc.

Figure 6 compares the same estimated hazard ratios as above to the corresponding observed hazard ratios for females and males. The strong correspondence between the estimated and observed hazard ratios confirms the validity of the algorithm used by Stamatakis, and subsequently by LifeQ.

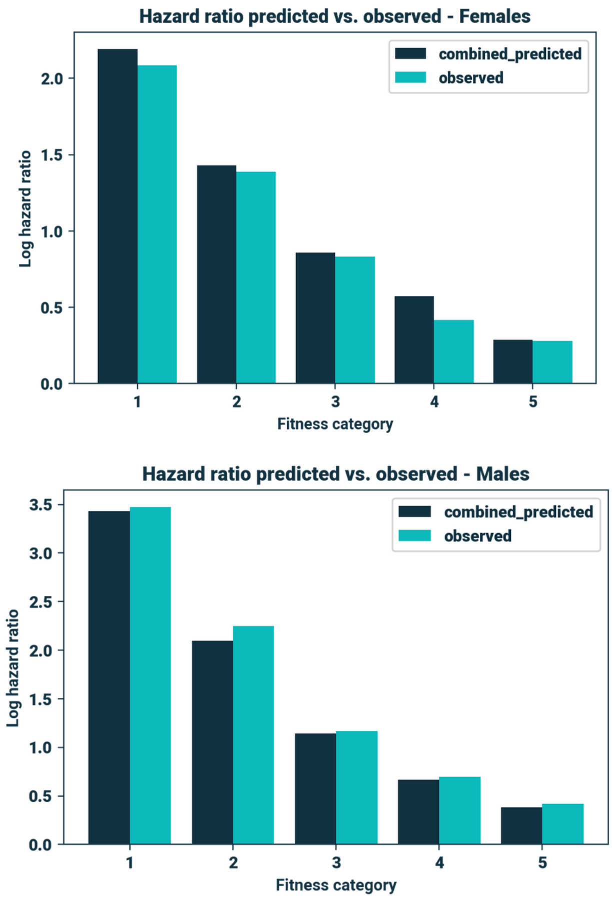


Figure 6. Comparison of estimated hazard ratios to the corresponding observed hazard ratios

Based on the Stamatakis model, the LifeQ pilot cohorts were discretized into five risk categories: "minimal", "low", "moderate", "high" and "highest". Figure 26 below illustrates the relationship between BMI and age, respectively, and an individual's risk classification. As expected, older individuals and individuals with a higher BMI have a higher mortality risk.

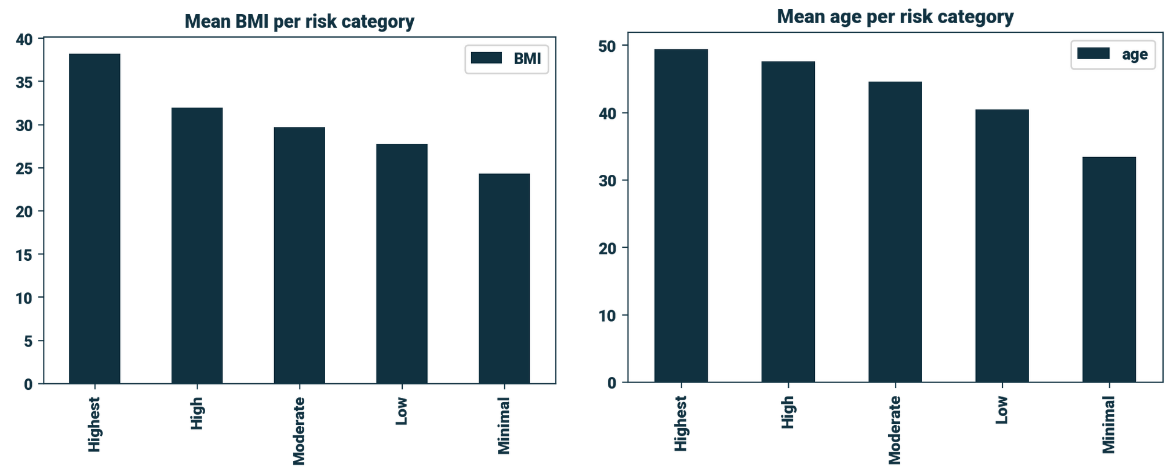


Figure 26. The relationship between BMI and age, respectively, and risk classification. As expected, older individuals and individuals with a higher BMI, on average, have a higher mortality risk.

Figure 7 shows that an increase in fitness score corresponds to decreased mortality risk, and that the discrepancies between risk groups are even more distinct than those seen in risk classification by BMI or age alone. In short, the fitness score provided by the LifeQ Fitness Score—which utilizes profile information (including BMI and age) in its calculations—facilitates a more comprehensive and clear-cut risk classification.

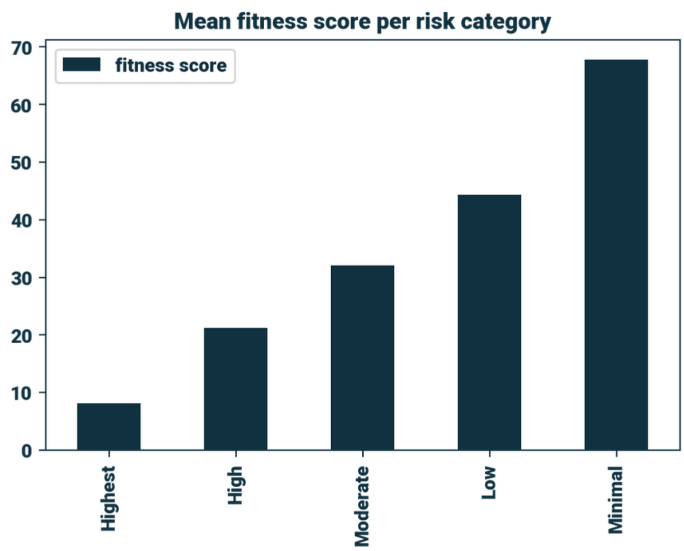


Figure 7. The relationship between fitness score and risk classification. An increase in fitness score, on average—which includes BMI and age in its calculation—corresponds to decreased mortality risk, and the discrepancies between risk groups are even more distinct than those seen in risk classification by BMI or age alone.

Constraints in estimating HHS accurately

Measuring VO_2max from a wrist-based device is complex and the technology has limitations owing to the nature and availability of a good signal. Accurate VO_2max is the most vital input of the LifeQ Fitness Health Score . Accuracy of this solution can be seen at VO2max Product Description_February 2021.

The LifeQ FHS requires at least 7 (non-consecutive) days of data within a 31- day period to output a score and will improve in stability and accuracy as more data becomes available.

The FHS has not been validated for individuals younger than 18 or older than 90 and should not be used to diagnose or classify users as ill or at risk of health problems. The purpose of the FHS score is only to provide users with a guide of how their fitness compares with other people of a similar age and gender. LifeQ recommends that users seek professional advice if they are concerned about their FHS score or would like to improve their score.