

LifeQ[®]

VO₂max

What is VO₂max?

VO₂max is the maximum rate at which an individual's heart, lungs, muscles and the rest of the body can effectively utilize Oxygen during exercise. As a measure of a person's aerobic capacity, VO₂max is an excellent benchmark for an individual's cardiorespiratory fitness. This benchmark can be used to assess an individual's fitness levels, set training goals and monitor fitness progress over time. Furthermore, VO₂max is also a powerful and independent predictor of all-cause and cardiovascular mortality.

Despite the clear value of VO₂max, traditional testing has remained limited due to the expense and rigorous nature of the testing done in a laboratory using indirect calorimetry.

To solve this problem LifeQ has developed three different wearable device based solutions for accurately estimating a person's VO₂max. The solutions all aim to provide VO₂max values as efficiently as possible, while accommodating a broad spectrum of fitness levels and activity interests.

What VO₂max Outputs are provided by LifeQ?

The LifeQ VO₂max solution includes the following outputs:

- **Profile VO₂max:** Using only the user's basic profile information including Age, Gender, Height, Weight and Resting Heart Rate, the solution provides an estimate of VO₂max.
- **Treadmill Protocol VO₂max:** A user-initiated test which requires a treadmill and is managed through an on-device or phone app providing the user with prompts and guidance. User's profile data as well as speed (from the treadmill) and heart rate data (from the wearable device) is used to calculate VO₂max.
- **Lifestyle VO₂max:** Using the user's basic profile information including Age, Gender, Height, Weight, Resting Heart Rate and exercise history, the solution provides an estimate of VO₂max.
- **Automated Running:** Automatically collected using speed and heart rate data collected from GPS enabled watches from users who run at least 3 times per month.

Table 1 - Overview of the LifeQ VO₂Max Solutions available

| Method | Requirements | Limitations |
|------------------------------------|---|---|
| Profile | User Profile (including updatable Weight and Resting Heart Rate) | Available to everyone continuously |
| Treadmill Protocol | User Profile Treadmill User follows a app based protocol | Immediate results, but requires treadmill and user engagement |
| Lifestyle VO₂max | User Profile History of moderate and vigorous activity sessions | Only available to those who participate in moderate to vigorous exercise |
| Auto Running | User Profile GPS device based speed and continuous | Low user action required, but user needs to run regularly and have GPS enabled device |

| | | |
|--|------------|--|
| | heart rate | |
|--|------------|--|

Accuracy

LifeQ has conducted numerous studies to validate the VO₂max solutions against the Gold-standard VO₂max GXT protocols using indirect calorimetry.

A summary of these results is provided below with a detailed description of the results available in the [LifeQ VO₂max Validation Document](#).

Table 2 - Summary of accuracy for LifeQ Profile Estimate VO₂max solution

| Participant group | Number of Participants | MAPE | SD |
|---------------------------------|------------------------|-------|-------|
| All participants | 63 | 15.18 | 14.08 |
| High BMI (BMI ≥ 25) | 26 | 16.46 | 19.20 |
| Athletic | 12 | 14.34 | 10.70 |
| Excluding high BMI and Athletic | 27 | 7.46 | 6.09 |

Table 3 - Summary of accuracy for LifeQ Submaximal Treadmill Running VO₂max solution

| Participant group | Number of Participants | MAPE | SD |
|---------------------------------|------------------------|-------|-------|
| All participants | 63 | 14.22 | 13.37 |
| High BMI (BMI ≥ 30) | 26 | 15.37 | 18.49 |
| Athletic | 12 | 15.47 | 7.35 |
| Excluding high BMI and Athletic | 27 | 5.36 | 3.92 |

Table 4 - Summary of accuracy for LifeQ Lifestyle VO₂max solution

| Participant group | Number of Participants | MAPE | SD |
|---------------------|------------------------|-------|-------|
| All participants | 43 | 16.96 | 10.37 |
| High BMI (BMI ≥ 25) | 18 | 14.80 | 8.94 |
| Athletic | 8 | 28.54 | 10.82 |

| | | | |
|--|----|-------|------|
| Excluding high BMI and Athletic | 27 | 10.20 | 6.25 |
|--|----|-------|------|

Table 5 - Summary of accuracy for LifeQ Automated GPS VO₂max solution

| Participant group | Number of Participants | MAPE | 5% Absolute Percentage Error | 95% Absolute Percentage Error |
|--|-------------------------------|-------------|-------------------------------------|--------------------------------------|
| All | 12 | 9.18 | 0.61 | 20.29 |
| High BMI (BMI ≥ 25) | 1 | 7.34 | 7.34 | 7.35 |
| Athletic | 1 | 10.66 | 10.66 | 10.66 |
| Excluding high BMI and Athletic | 10 | 9.22 | 0.51 | 20.58 |

Constraints on measuring VO₂max accurately

The accuracy of the LifeQ VO₂max solutions are dependent on accurate user profile, heart rate and speed values. Individual VO₂max values can also be impacted by the physiological state or wellness of an individual on a day, so the more frequently this can be assessed the better the accuracy will be.

Additionally for the more accurate Treadmill and Outdoor running solution a person must be able and willing to run at a consistent speed for a short period of time and have access to the necessary equipment.

Varying temperatures and weather conditions can also have an impact on the accuracy of the solution.