

# LifeQ

LifeQ VO<sub>2</sub> solution v1.0

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## Summary

- Oxygen consumption (VO<sub>2</sub>) is a measure of the volume of oxygen that the body uses to convert energy sources to adenosine triphosphate (ATP) for use on cellular level.
- The gold standard for VO<sub>2</sub> measurement is an expensive, time consuming indirect calorimetry test performed in a laboratory, making it unsuitable for frequent or continuous testing and inaccessible to most.
- The *LifeQ VO<sub>2</sub> solution v1.0* estimates continuous VO<sub>2</sub> during various levels of activity; during rest and graded exercise with a mean % error of 23,6% and 17,3% compared to the gold standard measurement.

## Key terms

- **VO<sub>2</sub>** = rate of oxygen consumption in the body in ml/min/kg
- **Indirect calorimetry** = the method of using gas exchange measurements (oxygen consumption, carbon dioxide production) to determine type and rate of substrate utilization
- **VO<sub>2</sub> max** = maximum rate at which oxygen can be utilized in the body (typically measured during maximum exertion)
- **Body Mass Index (BMI)** = derived from the weight and height of an individual (kg/m<sup>2</sup>) and serves as an indication of body composition.

## Introduction

Measurement of VO<sub>2</sub> provides insight into an individual’s aerobic activity, which is informative for sports/fitness; training progress, as well as rehabilitation treatment<sup>1,2</sup>. Furthermore, aerobic capacity has been found to correlate strongly with life expectancy, and serves as a robust, independent indicator of cardiovascular and all-cause mortality<sup>3,4,5,6</sup>.

Traditionally VO<sub>2</sub> is measured in a laboratory setting by trained technicians and involves indirect calorimetry techniques whereby respiratory gas exchange is measured using equipment such as a gas masks and metabolic carts. While this is considered the gold standard method for measuring VO<sub>2</sub>, it is time consuming, expensive, not conducive to frequent or continuous monitoring and inaccessible to most.

The *LifeQ VO<sub>2</sub> solution v1.0* estimates continuous VO<sub>2</sub> based on measured heart rate (HR) combined with other physiological parameters during various levels of activity including periods of rest, exercise and post-exercise recovery.

## Test Protocol

This validation study included 108 participants with a mean age of 33.3 years (21.0, 32.0, 48.0)\*, 34 of which were female

\* (5<sup>th</sup> percentile, median, 95<sup>th</sup> percentile)

and 74 were male. The mean BMI was 27.0 (19.4, 25.2, 37.8)\*, and the mean VO<sub>2</sub> max was 42.0 ml/min/kg (24.0, 34.2, 59.8)\*. The following physiological parameters were collected for each participant:

- Height (m)
- Age (yrs)
- Weight (kg)
- Gender
- Resting heart rate (beats per min)
- Actual (measured by indirect calorimetry) VO<sub>2</sub> max (ml/kg/min)

Based on these physiological parameters, a user specific heart rate - VO<sub>2</sub> relationship was generated by the *LifeQ VO<sub>2</sub> solution v1.0* that enabled real time VO<sub>2</sub> to be estimated during rest (including supine, sitting and standing positions) and graded exercise.

The *LifeQ VO<sub>2</sub> solution v1.0* was compared to the gold standard laboratory based VO<sub>2</sub> measurements obtained using indirect calorimetry during rest and graded exercise, and the accuracy determined as follows and expressed as a mean absolute percentage error (MAPE).

$$MAPE = \frac{100}{N} \times \sum_{VO_2=1}^N \left| \frac{(measured\ VO_2) - (predicted\ VO_2)}{measured\ VO_2} \right|$$

Where N = the number of datasets in the study.

## Results

The accuracy of the *LifeQ VO<sub>2</sub> solution v1.0* estimations compared to the gold standard measurements are summarized in [Table 1](#).

**Table 1:** Mean absolute percentage error of the *LifeQ VO<sub>2</sub> solution v1.0* estimations compared to gold standard measurements during rest, and during graded exercise & recovery.

	Accuracy during rest	Accuracy during graded exercise & recovery
MAPE (%)	<b>23.6</b> (2.0, 20.2, 51.5)*	<b>17.3</b> (0.9, 10.9, 52.1)*
Correlation (R)	<b>0.980</b>	<b>0.972</b>

\* (5<sup>th</sup> percentile, median, 95<sup>th</sup> percentile)

A small group of outliers (n=3) was identified in the collected data. These were found to be low-lung function participants, who displayed a MAPE of 31.2%.

Participants were further categorized into three groups:

- uncategorized (BMI<30, non-athletes) (A)
- high BMI (BMI>30) (B), and athletic (C)

Athletes were classified according to their VO<sub>2</sub> max, age and sex <sup>7</sup>. Uncategorized participants displayed a relatively low MAPE of 15.6%, whereas high BMI and athletic participants displayed MAPEs of 21.3% and 20.2%, respectively ([Table 2](#)).

**Table 2:** MAPE distribution between estimated and measured VO<sub>2</sub> values in uncategorized, athletic and high BMI participants during rest, and during graded exercise & recovery.

	Uncategorized (A)	High BMI n=32 (B)	Athlete n=16 (C)
MAPE Rest (%)	<b>20.6</b> (1.6, 17.3, 48.9)*	<b>35.6</b> (2.2, 23.4, 78.6)*	<b>28.8</b> (2.4, 22.0, 61.0)*
MAPE Exercise, recovery (%)	<b>15.6</b> (0.9, 10.2, 47.6)*	<b>21.6</b> (1.3, 14.2, 62.6)*	<b>20.2</b> (0.7, 9.3, 64.2)*

\* (5<sup>th</sup> percentile, median, 95<sup>th</sup> percentile)

\* (5<sup>th</sup> percentile, median, 95<sup>th</sup> percentile)

## Conclusion

The *LifeQ VO<sub>2</sub> solution v1.0* provides a continuous estimate of VO<sub>2</sub> which can be applied to enable individuals to improve their wellness and athletic ability. Furthermore, aerobic capacity correlates strongly with life expectancy, and serves as a robust, independent indicator of cardiovascular and all-cause mortality. Aerobic capacity data can be used as a powerful tool in risk stratification and decision making in disease prevention and various clinical settings<sup>8,9,10,11</sup>.

## References

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