LifeQ

LifeQ Energy Expenditure solution

Version 1.0

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Summary

- Energy expenditure refers to the amount of energy required by an individual to maintain basic body functions such as breathing, circulations, digestions as well as physical activity.

- Accurate and accessible energy expenditure measurement may enable an individual to make changes to promote a healthy life-style.

- Gold standard methods for measuring energy expenditure are typically expensive, time consuming, unsuited for frequent or continuous testing and inaccessible to most.

- The *LifeQ Energy Expenditure solution v1*.0 allows continuous estimation of energy expenditure during various levels of activity with accuracy levels of 22% (R=0.942) and 11,3% (R=0.989) during rest and graded exercise respectively, compared to a gold standard indirect calorimetry measurement.

Key terms

- **Energy Expenditure (EE)** = the amount of energy an individual requires to maintain basic body functions and physical activity
- **Indirect calorimetry =** the method of using gas exchange measurements (oxygen consumption, carbon dioxide production) to determine type and rate of substrate utilization
- **VO_2 max** = the maximum rate of oxygen consumption (ml/min/kg)
- **Body Mass Index (BMI)** = derived from the mass (weight) and height an and individual (kg/m^2) and serves as an indication of body composition.

Introduction

Low energy expenditure (EE) combined with excessive food intake is the most common cause of obesity, which may result in life threatening disorders, such as[1]:

- Type 2 diabetes
- Heart disease
- Obstructive sleep apnea
- Certain types of cancers

Accurate and accessible energy expenditure (EE) estimations may facilitate weight loss, prevent weight gain, provide motivation for personal physical activity, and provide guidance during fitness training regimens.

Several gold standard techniques are available for measuring energy expenditure. These include techniques such as indirect calorimetry (using gas exchange to determine the type and rate of substrate utilization) and the doubly labeled water technique (whereby water labeled with heavy, non-radioactive form of deuterium and oxygen-18 is administered and the rate of elimination is measured through regular sampling of saliva, urine or blood). These approaches typically require administration by highly trained professionals and tend to be invasive, expensive and uncomfortable. Furthermore, testing is limited to individuals that are in a state of post exercise rest and recovery. Therefore, these methods are not conducive to continuous monitoring.

The *LifeQ Energy Expenditure solution v1.0* allows continuous estimation of energy expenditure during various levels of activity based on measured heart rate (HR) combined with other physiological parameters.

Test Protocol

This validation study included 108 participants with a mean age 33.3 years

(21.0, 32.0, 48.0)[*], 34 of which were female and 74 were male, with a mean BMI of 27.0 (19.4, 25.2, 37.8)[*], and a mean VO_2 max of 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 minute)
- Actual (measured by indirect calorimetry) VO_2 max

Resting heart rate and VO_2 max were measured using a chest strap heart rate monitor, a BioHarness[TM] device and a metabolic cart.

The *LifeQ Energy Expenditure solution v1.0* was compared to the gold standard laboratory based EE measurements obtained using indirect calorimetry during rest and graded exercise. The accuracy, expressed as a mean absolute percentage error (MAPE), was determined as follows:

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

Where N = the number of datasets in the study.

Results

The accuracy of the *LifeQ Energy Expenditure solutions v1.0* estimations compared to the gold standard indirect calorimetry measurement is summarized in Table 1.

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[*] (5th percentile, median, 95th percentile)

Table 1: Mean absolute percentage error of the LifeQ Energy Expenditure solution v1.0 estimations compared to gold standard measurements during rest and graded exercise.

	Accuracy during rest	Accuracy during graded exercise & recovery
MAPE (%)	**22.0** (2.7, 19.9, 46.4)*	**11.3** (0.9, 7.3, 32.8)*
Correlation (R)	**0.942**	**0.989**

[*](5th percentile, median, 95th percentile)

A small group of outliers (n=3) was identified in the collected data. These were found to be low-lung function participants, and displayed an over-estimation of energy expenditure with a mean percentage error of 27,1%.

Participant where further categorized into three groups:

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

The accuracy of the *LifeQ Energy Expenditure solution v1.0* estimations compared to the gold standard indirect calorimetry measurements across these groups is summarized in Table 2.

Table 2: Mean absolute percentage error (MAPE) of the *LifeQ Energy Expenditure solution v1.0* estimations compared to the gold standard indirect calorimetry measurement in uncategorized (A), high BMI (B) and athletic (C) participants during rest, and graded exercise & recovery.

	Uncategorized (A)	High BMI n=32 (B)	Athlete n=16 (C)
MAPE Rest (%)	**20.3** (2.2, 16.9, 49.0)*	**31.3** (3.3, 23.5, 57.7)*	**23.4** (2.2, 21.2, 48.0)*
MAPE Exercise, recovery (%)	**10.1** (0.7, 5.9, 33.1)*	**13.6** (1.3, 10.7, 32.9)*	**11.8** (1.1, 7.4, 33.9)*

[*](5th percentile, median, 95th percentile)

Conclusion

Continuous energy expenditure estimations by the *LifeQ Energy Expenditure solution v1.0*

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provides insight into day-to-day and long term energy expenditure patterns and changes in energy expenditure in relation to physical activity, enabling the user to:

- Set daily targets for physical activity
- Manage daily energy expenditure with nutritional planning
- Evaluate the amount of exercise required to meet daily targets
- Compare the energy expenditure values of different types of physical activity

Furthermore, access to continuous energy expenditure data can enable health care professionals to prescribe lifestyle adjustments necessary to support optimal health and diagnose conditions related to abnormal energy expenditure. Decreased resting energy expenditure is associated with overt hypothyroidism and weight gain, while an increased resting energy expenditure is associated with hyperthyroidism, weight loss[2,3] and type 2 diabetes[4].

References

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