Breezing

Mobile Indirect Calorimeter

Outline

Indirect Calorimetry and mobile device accuracy

Pre-measurement - The patient's education and preparation

Pre-measurement – The professional's training:
app and device management

During the measurement – The professional's training:
Conditions and Procedure

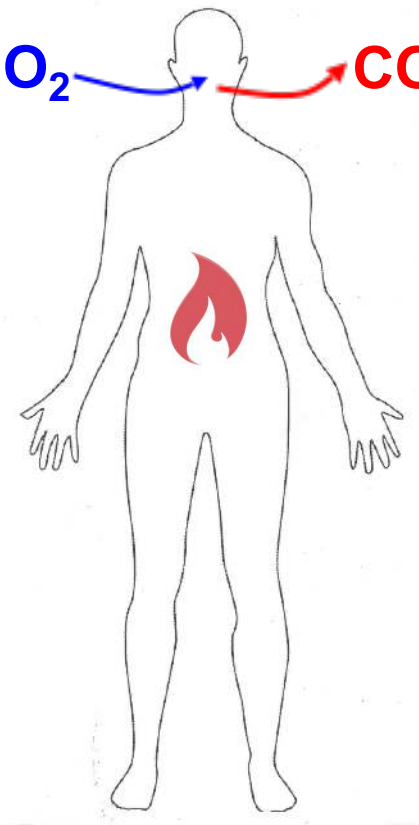
Post- measurement – The patient's education

Weight drop and REE drop

Breezing Studies

Function of Metabolism

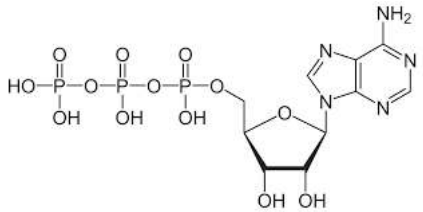
Food +
Oxygen



ATP (heat energy) +
Carbon Dioxide

- ***VO_2 consumed oxygen rate***

- ***VCO_2 produced carbon dioxide rate***



Resting Energy Expenditure (REE)

Weir Equation:

$$REE\ (kCal/day) = [3.9\ (VO_2) + 1.1\ (VCO_2)] \times 1.44$$

VO_2: consumed oxygen rate (mL/min)
VCO_2: produced carbon dioxide rate (mL/min)

Weir, J. B. D. (**1949**). "New Methods For Calculating Metabolic Rate With Special Reference To Protein Metabolism." Journal Of Physiology-London **109**(1-2): 1-9.

Weir, J. B. D. (**1990**). "Nutrition Metabolism Classic - New Methods For Calculating Metabolic-Rate With Special Reference To Protein-Metabolism." Nutrition **6**(3): 213-221.

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VO_2: consumed oxygen rate (mL/min)
VCO_2: produced carbon dioxide rate (mL/min)

Methods using VO_2 ONLY use: $RQ = VCO_2 / VO_2 = 0.85$

$VCO_2 = 0.85 * VO_2$

$$REE\ (kCal/day) = [3.9\ (VO_2) + 1.1\ (0.85 * VO_2)] \times 1.44$$

Too big of the assumption!

Reality is the RQ can range from 0.70 to 1.00

0.70 - Energy Deficit (weight loss)

1.00 - Metabolic syndrome/ Diabetes

Weir, J. B. D. (**1949**). "New Methods For Calculating Metabolic Rate With Special Reference To Protein Metabolism." Journal Of Physiology-London **109**(1-2): 1-9.
Weir, J. B. D. (**1990**). "Nutrition Metabolism Classic - New Methods For Calculating Metabolic-Rate With Special Reference To Protein-Metabolism." Nutrition **6**(3): 213-221.

B

Indirect Calorimeters - Choices

Methods using VO_2 ONLY use: $RQ = VCO_2 / VO_2 = 0.85$

VCO_2 = guessed!

$4,000

Option 2

Methods using both VCO_2 and VO_2: $RQ = VCO_2 / VO_2$

VCO_2 = Known!

Weir, J. B. D. (**1949**). "New Methods For Calculating Metabolic Rate With Special Reference To Protein Metabolism." Journal Of Physiology-London **109**(1-2): 1-9.

Weir, J. B. D. (**1990**). "Nutrition Metabolism Classic - New Methods For Calculating Metabolic-Rate With Special Reference To Protein-Metabolism." Nutrition **6**(3): 213-221.

B

For Your Next Run… Would You Choose One Shoe or Two Shoes?

Importance of REE (or RMR) in Weight Management

Position of the American Dietetic Association: Weight Management

This paper endorsed by the American College of Sports Medicine

J Am Diet Assoc. 2009;109:330-346.

EAL Recommendation "Estimated energy needs should be based on [resting metabolic rate]. If possible, [resting metabolic rate] should be measured (eg, indirect calorimetry). **Rating: Strong**

H. Seagle, G. W. Strain, A. Makris, and R. S. Reeves, "Position of the American Dietetic Association: Weight Management," Journal of the American Dietetic Association, vol. 109, pp. 330-346, 2009.

Position of the Academy of Nutrition and Dietetics: Interventions for the Treatment of Overweight and Obesity in Adults

JOURNAL OF THE ACADEMY OF NUTRITION AND DIETETICS

January 2016 Volume 116 Number 1

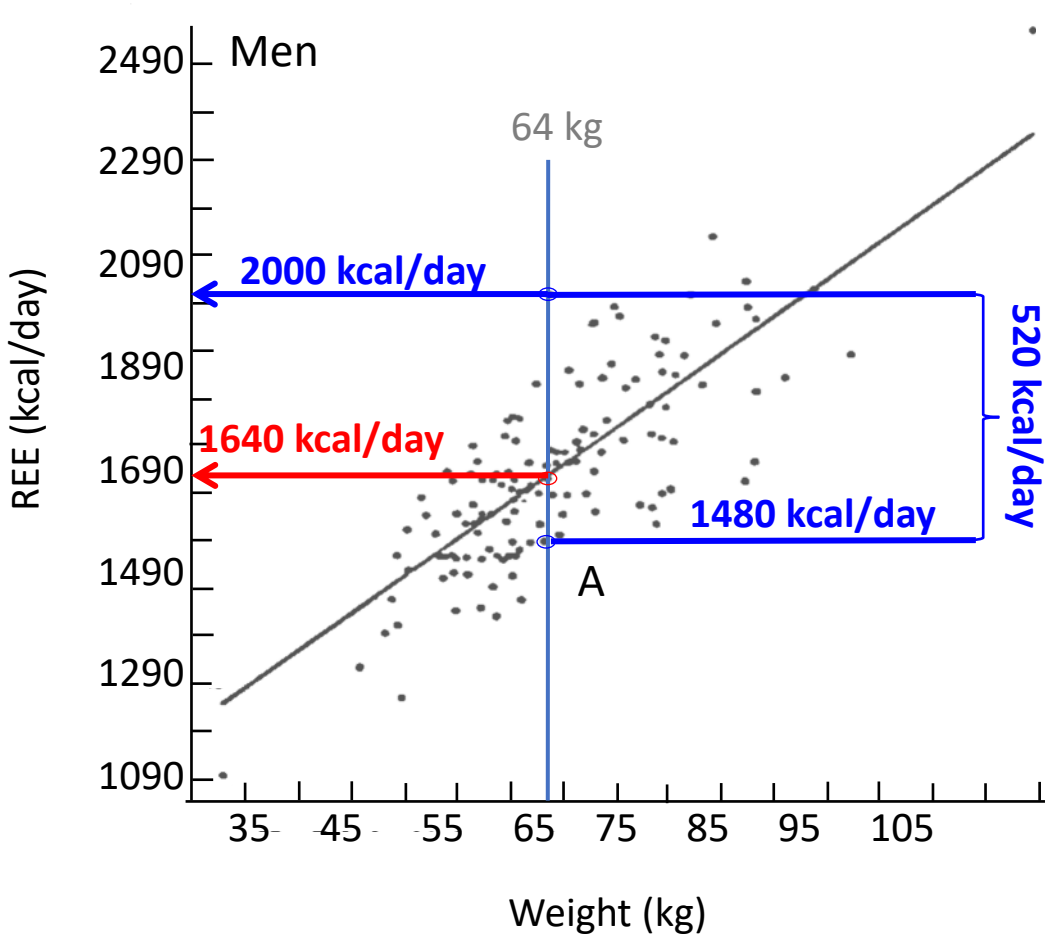
EAL Recommendation: "If indirect calorimetry is available, the RDN should use a measured resting metabolic rate (RMR) to determine energy needs in overweight or obese adults." (Rating: Consensus, Conditional)

Hollie A. Raynor, PhD, RD, LDN; Catherine M. Champagne, PhD, RDN, LDN, FADA. Journal of the American Dietetic Association, vol. 116, pp. 129, 2016.

Resting Energy Expenditure (**REE**)= Resting Metabolic Rate (**RMR**) = "Metabolism"

B

Why can't we use equations to calculate REE?



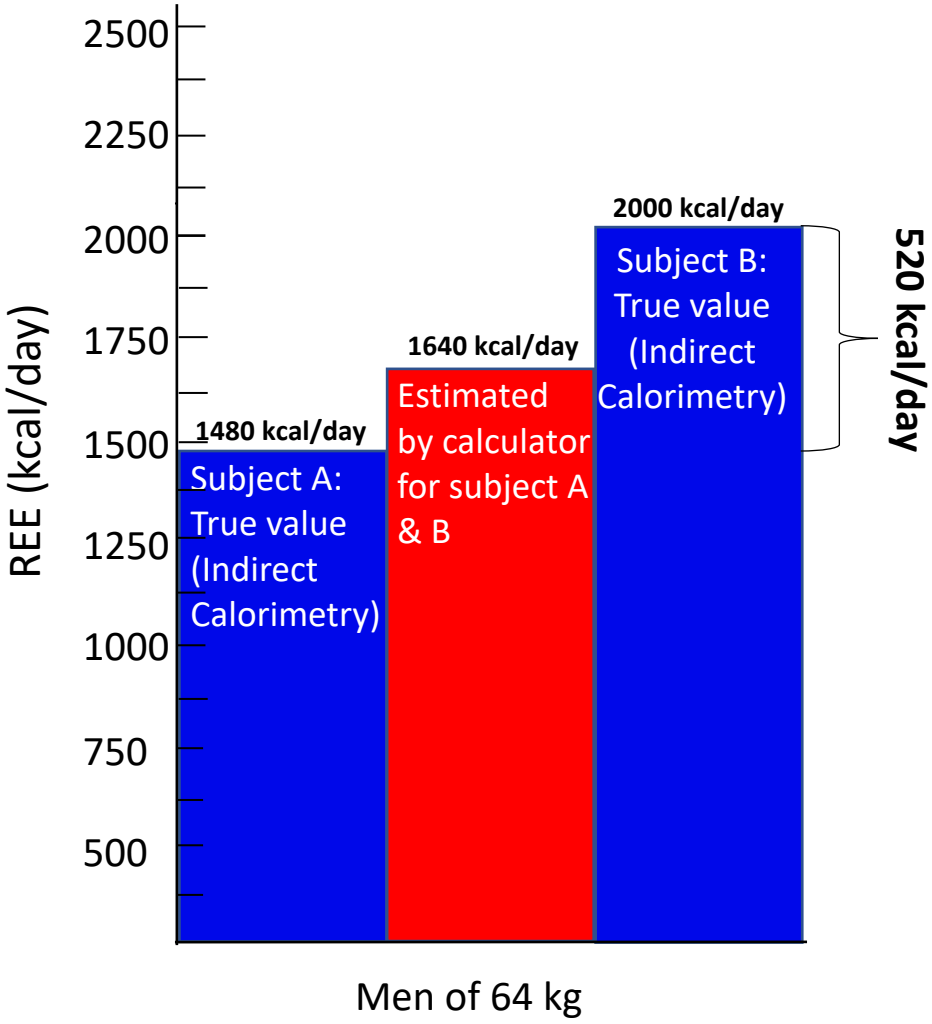
- ✓ An actual REE value (from indirect calorimetry measurement) can differ from an estimated REE value (from the *Harris-Benedict* calculation).
- ✓ The results show that for people of same gender and weight (e.g. men and 64 kg) the difference in actual RMR values can be as high as 520 kcal/day.
- ✓ If, for instance, subject A's goal is to maintain weight, and the estimated REE (1640 kcal/day) is higher than the body's actual REE (1480 kcal/day), a calorie recommendation based on the REE estimate will lead to weight gain.
- ✓ **Therefore, accurately *measuring* REE is crucial in establishing an effective weight management plan.**

Plot from J. Arthur Harris and Francis G. Benedict, A Biometric Study of Human Basal Metabolism, Proc Natl Acad Sci U S A. 1918 December; 4(12): 370–373.

Criscione, L. & Durr-Gross, M. Eating healthy and dying obese. Vitasanas GmbH, http://www.vitasanas.ch, ISBN: 978-3-0033-02225-6 (2010).

B

Why can't we use body fat impedance analyzer for REE?



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Values extracted from:

Plot from J. Arthur Harris and Francis G. Benedict, A Biometric Study of Human Basal Metabolism, Proc Natl Acad Sci U S A. 1918 December; 4(12): 370–373.

Why we can't use body fat impedance analyzer for REE ?

Prediction of resting energy expenditure from fat-free mass and fat mass[1,2]

Karl M Nelson, Roland L Weinsier, Calvin L Long, and Yves Schutz *Am J Clin Nutr* 1992:56:848–56.

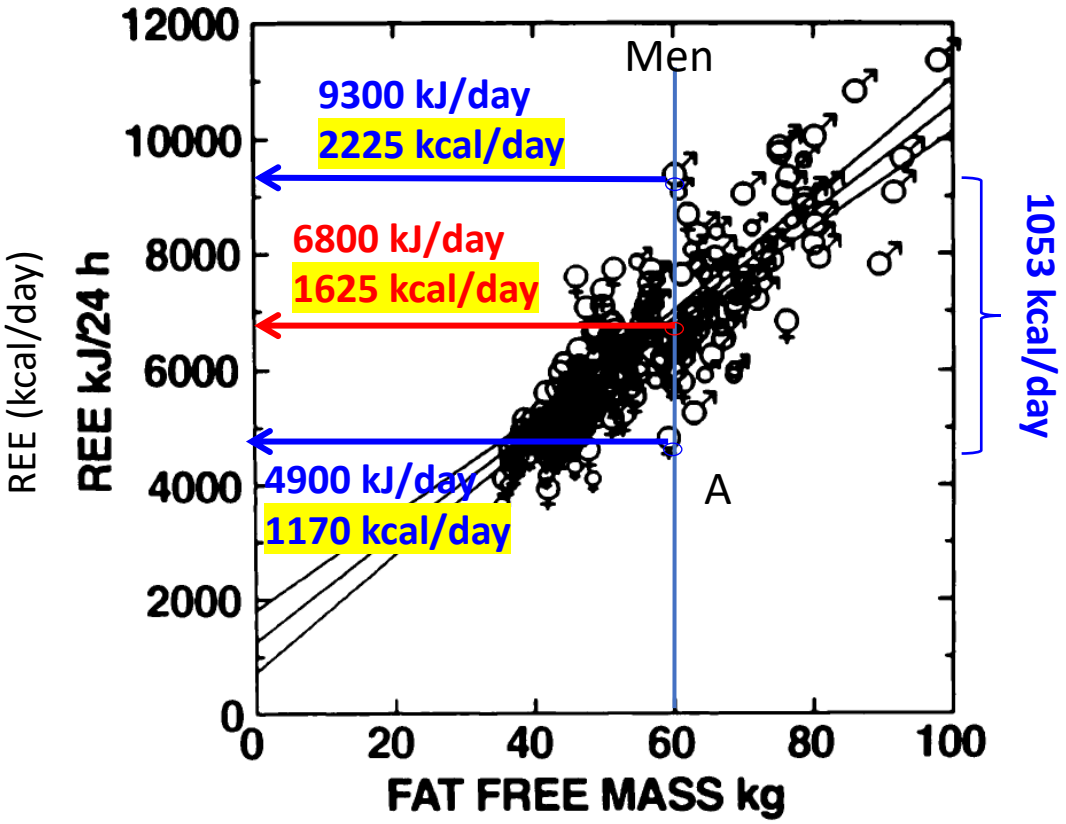
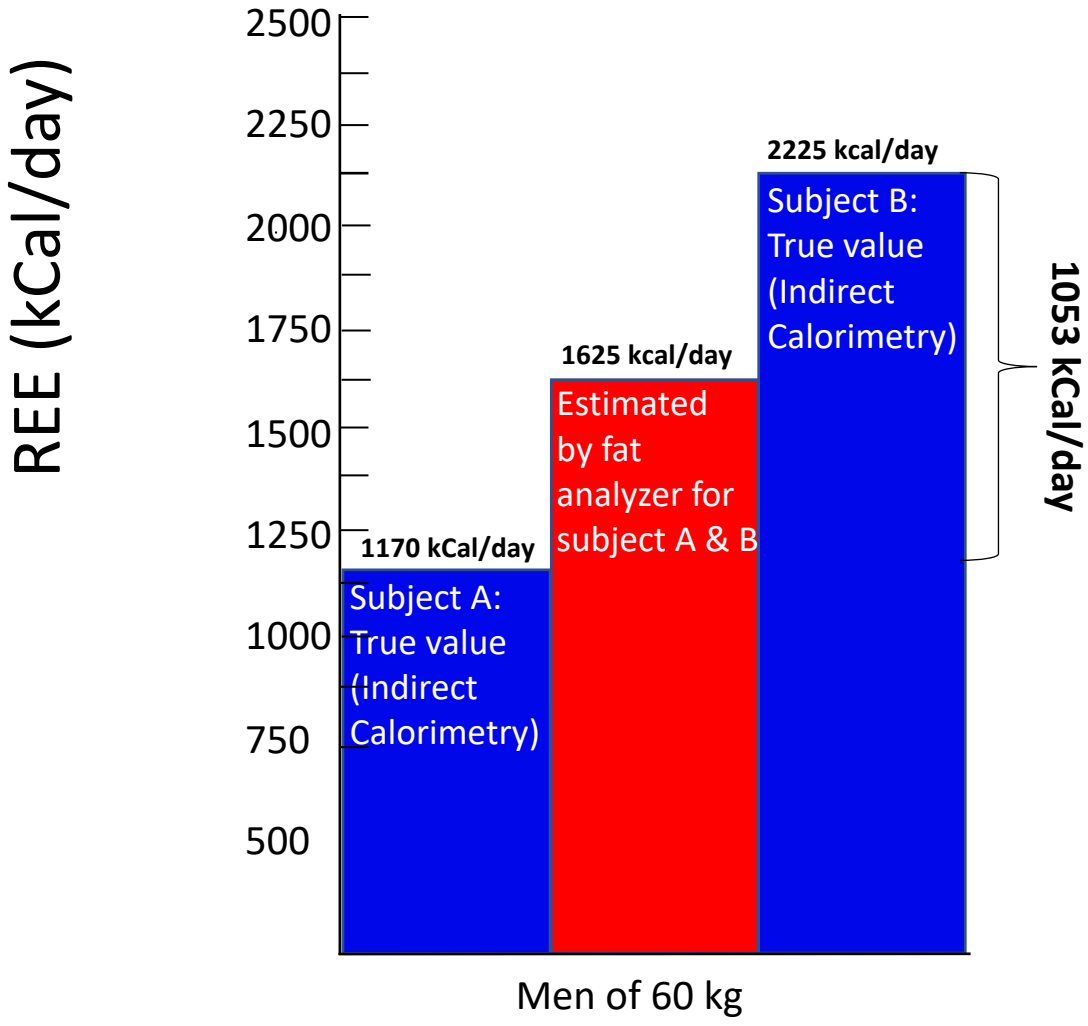


FIG 2. Regression of resting energy expenditure (REE) on fat-free mass (FFM). Lean individuals are indicated by the small symbols. Obese individuals are indicated by the large symbols. The line is the regression equation REE = 1265 + (93.3 × FFM) (Table 3) with a 95% confidence interval.

- ✓ An actual REE value (from indirect calorimetry measurement) can differ from an estimated REE value (from FFM calculation).
- ✓ The results show that for people of same gender and FFM (e.g. men and 60 kg) the difference in actual RMR values can be as high as **2225** kcal/day.
- ✓ If, for instance, subject A's goal is to maintain weight, and the estimated REE (**1625** kcal/day) is higher than the body's actual REE (**1170** kcal/day), a calorie recommendation based on the FFM estimate will lead to weight gain.
- ✓ **Therefore, accurately *measuring* REE is crucial in establishing an effective weight management plan.**

B

Why can't we use body fat impedance analyzer for REE?



- ✓ An actual REE value (from indirect calorimetry measurement) can differ from an estimated REE value (from FFM calculation).
- ✓ The results show that for people of same gender and FFM (e.g. men and 60 kg) the difference in actual RMR values can be as high as 2225 kcal/day.
- ✓ If, for instance, subject A's goal is to maintain weight, and the estimated REE (1625 kcal/day) is higher than the body's actual REE (1170 kcal/day), a calorie recommendation based on the FFM estimate will lead to weight gain.
- ✓ **Therefore, accurately *measuring* REE is crucial in establishing an effective weight management plan.**

Values extracted from: *Nelson KM, Weinsier RL, Long CL, Schutz Y. Prediction of resting energy expenditure from fat-free mass and fat mass. Am J Clin Nutr. 1992;56(5):848-856. doi:10.1093/ajcn/56.5.848*

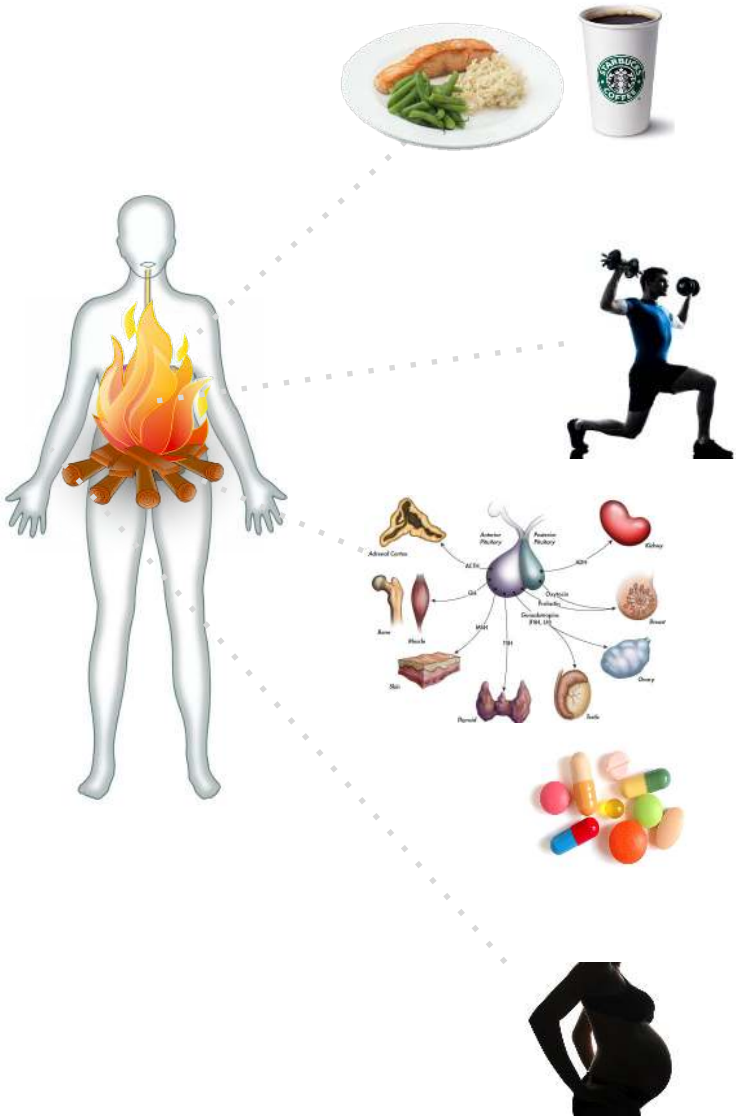
B

Why is it Important to Measure?

- Complications of overfeeding in critically ill patients

- Indirect Calorimetry in Clinical Practice

Breezing Study Cases



Diet

Changes in diet can significantly change metabolism. For example, a crash diet can cause drastic reduction in metabolic rate, leading to a “weight loss plateau”.

U of Arizona, Dr. C. Stump, MD, PhD Ow/Ob Patients
Banner Health, Dr. F. Soto, MD, Obesity Week, 2017

Exercise

Exercise can affect metabolism. For example, muscle-building increases metabolism and High Intensity Intermittent Training (HIIT) creates an “afterburn” effect.

Training Facility/ASU, B. Ainsworth, HIIT, “Personal Mobile Tracking of Resting and Excess Post-Exercise Oxygen Consumption with a Mobile Indirect Calorimeter” Issue no. 11, 2019, Gazzetta Medica Italiana - Archivio per le Scienze Mediche

Hormones/medication/supplements

Hormonal changes (hyper- or hypo-thyroidism), medications, supplements can change metabolism.

Omnic Actives, Dr. V. Juturu, Capsacinoids

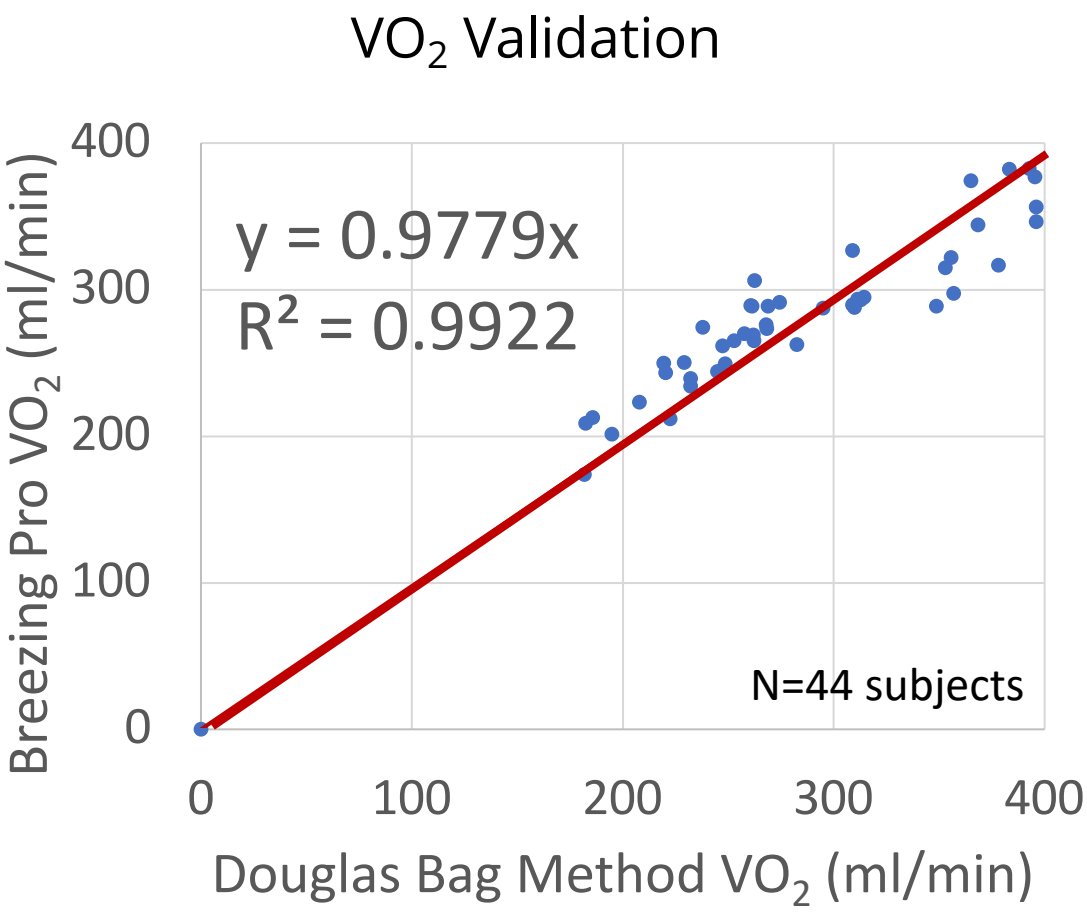
Pregnancy

Metabolism changes significantly throughout pregnancy and after giving birth. Tracking metabolism helps the mother maintain and achieve the proper weight for the baby’s healthy growth.

ASU, Dr. C. Whisner, Nutrition, PhD. Pregnancy
Penn State, Dr. D. Downs, Obesity Week 2017, NIH study

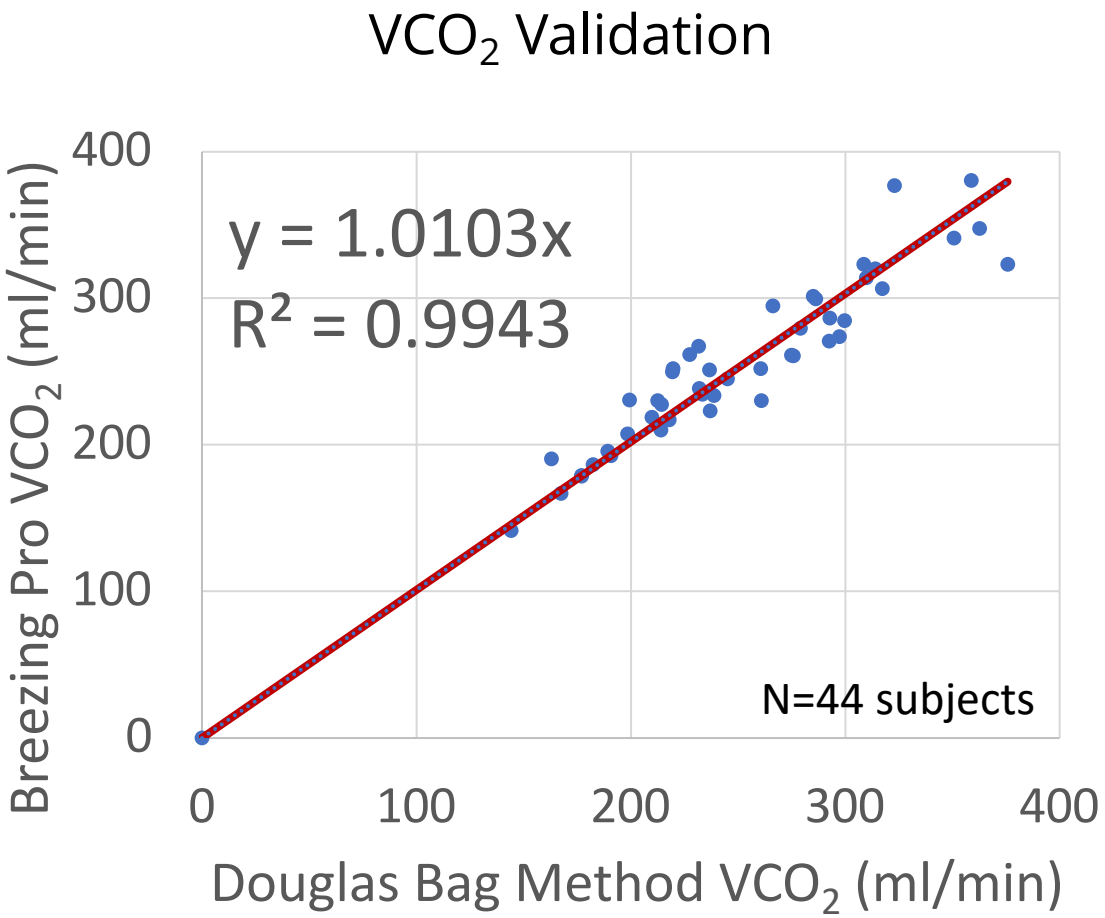
Indirect Calorimeter: The Wearable Mask – Breezing Pro

Validation Study: Breezing Pro vs. Douglas Bag Method



(single sensor batch)

Validation Study: Breezing Pro vs. Douglas Bag Method



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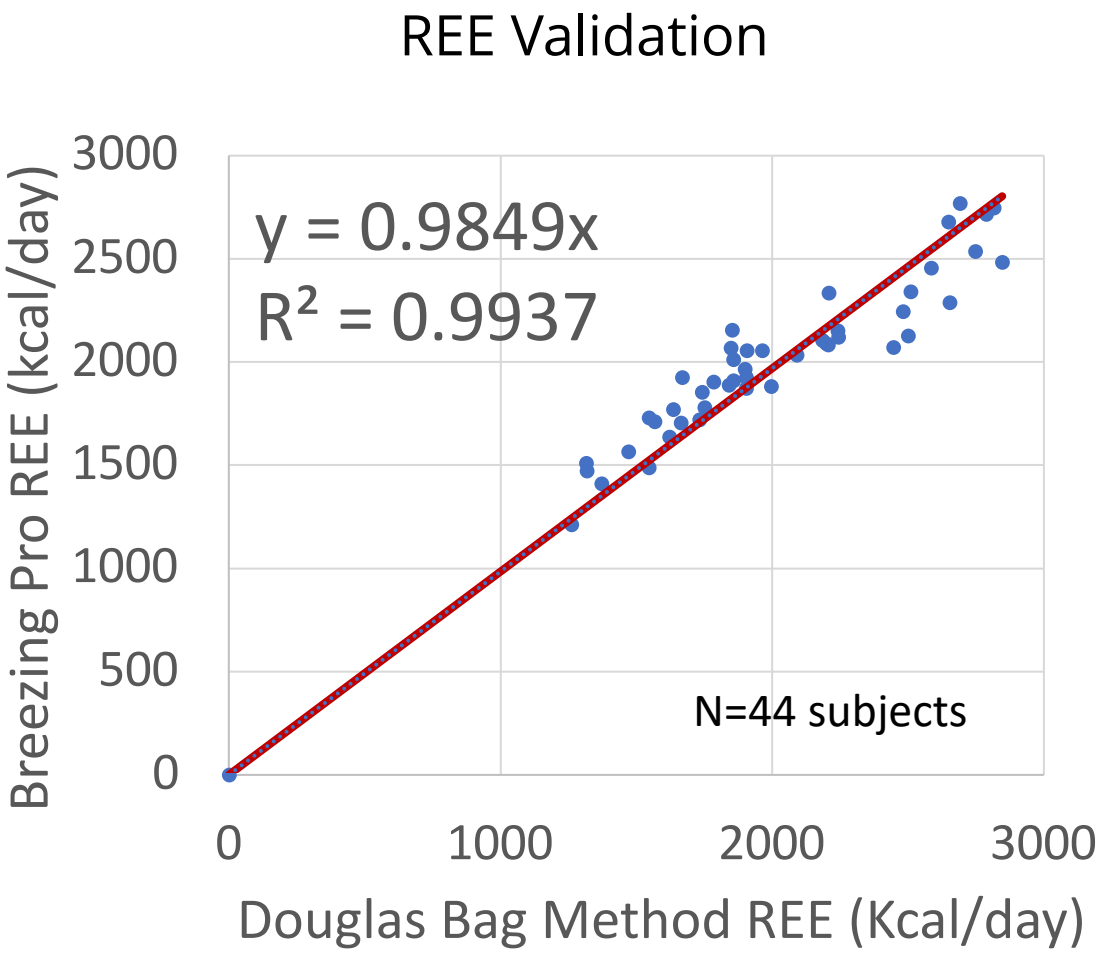
Validation Study: Breezing Pro vs. Douglas Bag Method

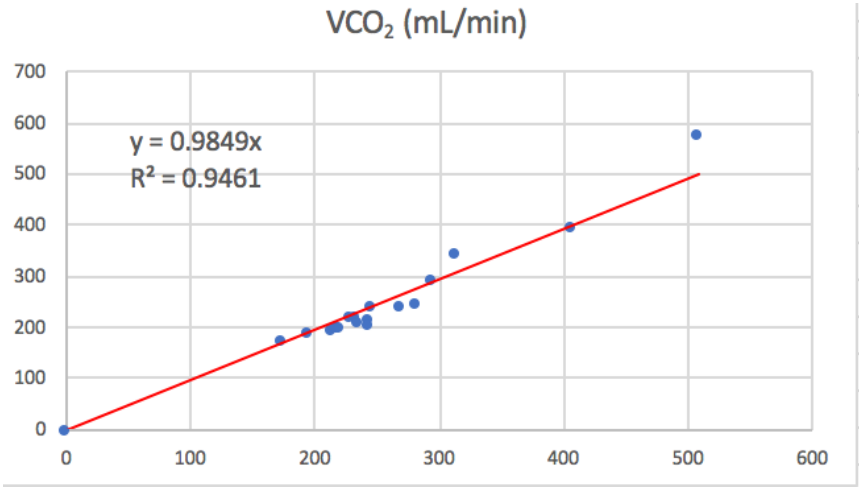


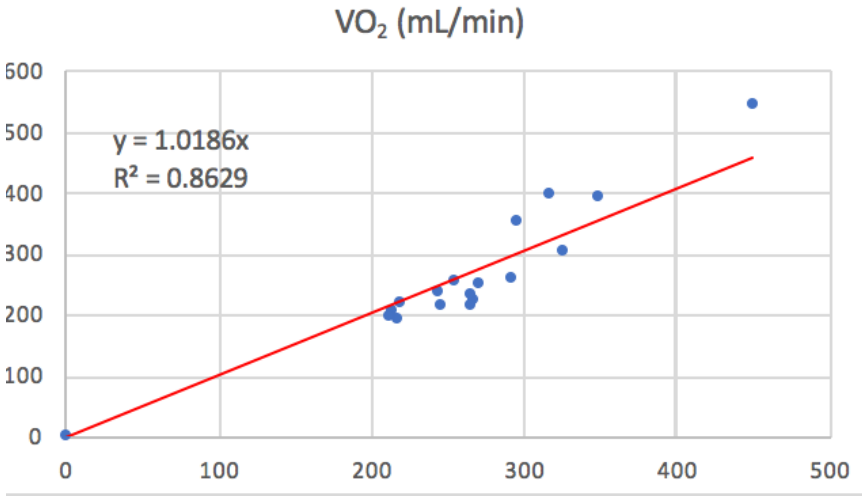
(single sensor batch)

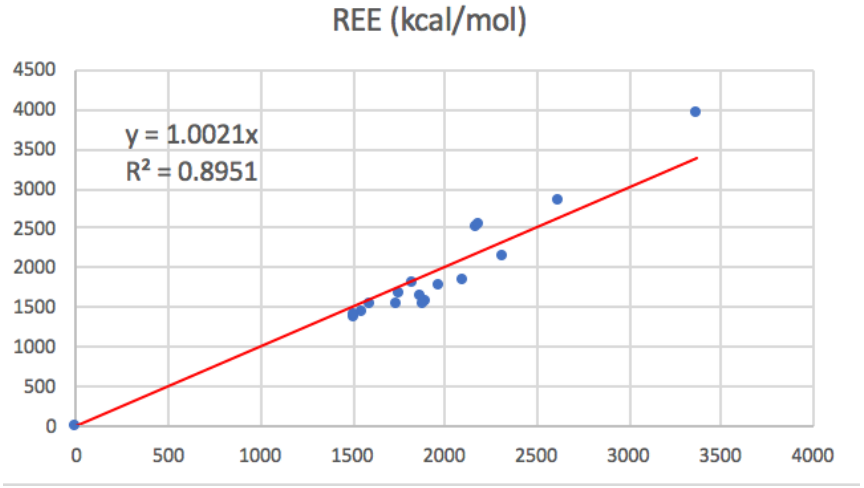
Validation Study: Breezing Pro vs. Medical Graphics (Ultima System)

Collaborations with Dr. Doina Kulick and Dr. Bruce Johnson, Mayo Clinic Arizona

Validation Study: Breezing Pro vs. Medical Graphics (Ultima System)







Analytical Validation Study Conclusion

- ✓ Total of subjects tested: 90+ with Gold standard method and Breath-by-Breath reference metabolic cart.
- ✓ Breezing Pro for VO2, VCO2, and Resting Energy Expenditure (REE) demonstrated ~100% accuracy
- ✓ Next: working on a clinical validation study with Mayo Clinic

Outline

✓ **Indirect Calorimetry, and mobile device accuracy**

Pre-measurement - The patient's education and preparation

Pre-measurement – The professional's training:
app and device management

During the measurement – The professional's training:
Conditions and Procedure

Post- measurement – The patient's education

Weight drop and REE drop

Breezing Studies

Promotion of Indirect Calorimetry in Clinics

Client Information Pamphlet

Ready to know your metabolism? Your measurement will take place on:

Before the Measurement

1. Make sure you wait at least 4 hours if you've eaten a moderate (~500 kCal) meal. Ideally, take the measurement first thing in the morning (overnight fasting).

2. Wait at least 4 hours after moderate exercise; at least 12 hours after strenuous exercise.

3. Drinking water before the measurement is fine, but avoid drinking coffee, tea, milk, or other beverages at least 4 hours before the measurement.

For more info, visit:
breezing.com

Application Notes
breezing.com/application-notes

FAQ
breezing.com/questions

View inspiring real user stories at https://vimeo.com/breezing/ or by searching for "Breezing Metabolism" on Youtube.

What people are saying:

"Crucial if you want to watch your weight."
BBC

"The next logical step in the ever-growing self-tracking movement."
Scientific American

"Here's a dieting tool that's quite breathtaking - literally."

Recommended by the American College of Sports Medicine, the American Diabetes Association, Academy of Nutrition and Dietetics, and the World Health Organization.

Pinterest pinterest.com/breezing	Twitter @bmetabolism
Facebook facebook.com/breezingco	Email info@breezing.com

If you have any questions about this appointment or measurement, contact:

www.breezing.com

Breezing Pro™

The world's first mobile metabolism tracker

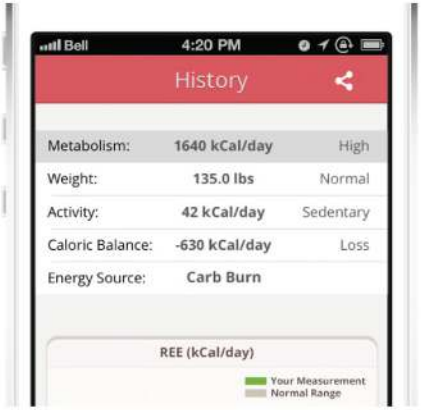
Avoid the weight plateau while losing weight

Stabilize your energy levels

Design a personalized diet and exercise plan

(back/front)

Client Information Pamphlet Cont.



Metabolism matters. It changes with age, stress, activity levels, diet, pregnancy, illness, medications, and other factors. Knowing metabolism can prevent the common "yo-yo pattern" of weight gain after initial weight loss, helps us find the most effective exercise/training program, and provides a more complete picture of our health. Breezing is the first to affordably, easily track how many total calories our bodies need each day – determined by our metabolism.

Do you know why you can't reach your weight goal?

= - [+]

Metabolism

Tracking **metabolism** gives you the missing information needed to reach your goal. Metabolism accounts for 75-95% of the calories your body burns. Breezing Pro™ measures the consumed oxygen rate and produced carbon dioxide rate through indirect calorimetry, the gold-standard method recommended by the Academy of Nutrition and Dietetics, the World Health Organization, and others.

Normal Metabolism: This is the population average. If your metabolism isn't "normal" that doesn't automatically mean something's wrong. Everyone is different.

Slower Metabolism: This could be caused by your diet and exercise program... or it could be your thyroid (hypothyroidism, for instance). Consult with your healthcare professional to find out.

Faster Metabolism: Usually, this is a "good thing" but not always. If your metabolic rate is too high, it could be a sign of hyperthyroidism. Speak with your healthcare professional to better understand what could be going on.

Find out more:
www.breezing.com

Breezing Pro™ is designed to help you succeed. How? The mask connects wirelessly with an app on the phone or tablet. **Measure** your metabolism by breathing into the mask. Create a customized **Plan** based on that measurement, your personal weight goals, and the date you'd like to reach those goals. **Achieve** your target by following the recommended exercise and diet plan. To keep yourself on track, just **re-measure** as needed. Simple.
In fact, studies show that Breezing Pro™ users are more successful in maintaining their goal weight than non-Breezing Pro™ users. It's all in the science.

Measure — Plan — Achieve — Re-Measure

(inside)

Patient Preparation and Education for the Test

Before the Measurement

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For more info, visit:
breezing.com

(Client Information Pamphlet)

B

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Weight drop and REE drop

Breezing Studies

Getting Familiar with the App

Online Version

Offline Version

Open app

Open the Breezing app on the tablet

Create client profile

Name

Fill in the client's personal information in the app

Download on the App Store

ANDROID APP ON Google play

Quick-start Manual

GETTING STARTED WITH BREEZING PRO™

1. Before placing the mask on the patient's face have at least two Velcro straps tightened.

2. Place the mask on the patient's face, ask the patient to help you hold the mask in the right place (over the nose and mouth), and grab the two remaining loose straps. Pass the two straps over the head and tighten them so that all straps are symmetrically tight around the head.

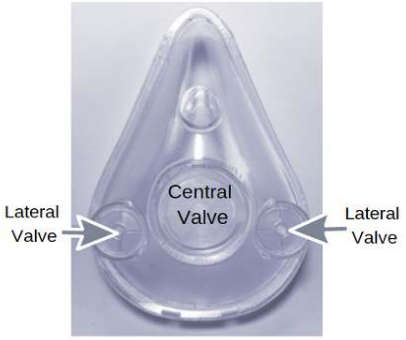
3. To avoid leaks, tighten all straps enough so that disposable mask is completely flush with the patient's face.

TIPS BEFORE YOU START

THE DISPOSABLE MASK

Place the disposable mask on the client's face, without attaching it to the Breezing Pro.™ Then have the client breathe in and out, making sure no air escapes during the process. If a stream of air passes through the edge of the mask, readjust the mask.

Ensure that the air valves open and close correctly. Lateral valves should open upon inhalation and the central valve should open during exhalation.



HOW TO AVOID "LEAKS"

Make sure the mask strap can be securely fastened around the client's head. For clients with long hair, you may want to tie the hair up (e.g. ponytail) to ensure a better fit.

Attach the disposable mask

Then position the strap over the head, like so:

(view from side) (view from back)

Once you've ensured the strap fits properly (doesn't slide around on the client's head), ask the client if he/she perceives "leaks" (stream of air on the face passing through the edge of the mask). **Readjust the mask position as needed to avoid any leaks.**

Outline

✓ **Indirect Calorimetry, and mobile device accuracy**

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During the measurement – The professional's training: Conditions and Procedure

Post- measurement – The patient's education

Weight drop and REE drop

Breezing Studies

Optimal Conditions for Measurement

Evidence Analysis Library Review of Best Practices for Performing Indirect Calorimetry in Healthy and Non–Critically Ill Individuals

Susan Fullmer, PhD, RDN; Sue Benson-Davies, PhD, DCN, MPH, RDN; Carrie P. Earthman, PhD, RD, LD; David C. Frankenfield, MS, RD; Erica Gradwell, MS, RD; Peggy S. P. Lee, MSc, RD; Tami Piemonte, MS, RDN, LD/N; Jillian Trabulsi, PhD, RDN

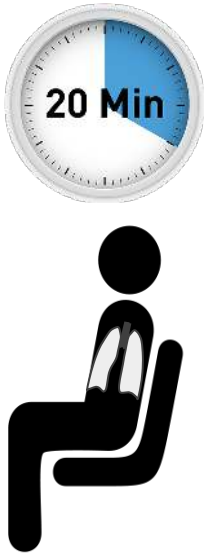
Phase 3 measurement protocols	
Rest period (adults)	Stated 20-min minimum rest period or a 15-min rest period if stated that first 5 min are discarded.
Fasting period	Stated minimum 7-h fast, or overnight

[a]See text for phase 1.

[b]RCT=randomized controlled trial.

[c]VO_2=oxygen consumption.

Figure 1. Phase 2 and 3[a] of search strategy and inclusion and exclusion criteria (resulted in elimination of 362 articles).



JOURNAL OF THE ACADEMY OF NUTRITION AND DIETETICS
September 2015 Volume 115 Number 9

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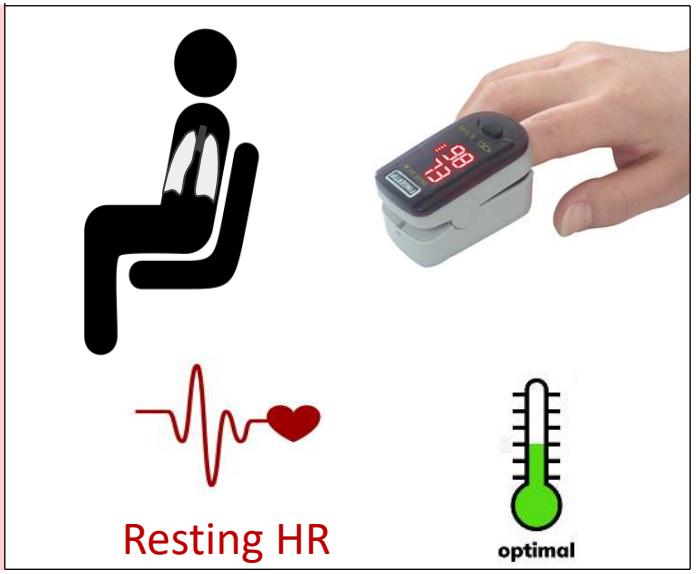
Optimal Conditions for Measurement

RESTING CONDITIONS

Make sure the client is seated for several minutes in a quiet, comfortable environment (room temperature). To ensure the client is truly at rest, assess their physiological state with a heart rate or blood pressure monitor.

The client should be seated for the measurement.



Patients with exhalation rates between 3.5 L/min and 10-11 L/min

B

Optimal Conditions for Measurement Cont.

Dos and Don’ts:

- ***Do*** take normal breaths while sitting in a relaxed, straight position.

- ***Don’t*** take deep and/or slow breaths.

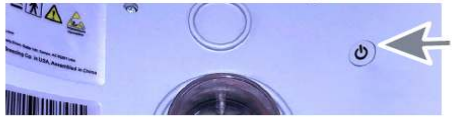
Measurement Guidelines

From the Quick start Manual*

*Also see the Breezing Pro step-by-step guide in pdf (ppt) file

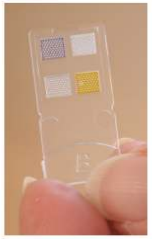
THE MEASUREMENT

1. Make sure the the Breezing Pro™ and included tablet are fully charged, open the app and follow the instructions onscreen.
Do not remove the sensor cartridge from the packaging until the app instructs you to insert the sensor cartridge.



2. Turn on the device by pressing and holding the Power button (on the back) for 2 seconds.

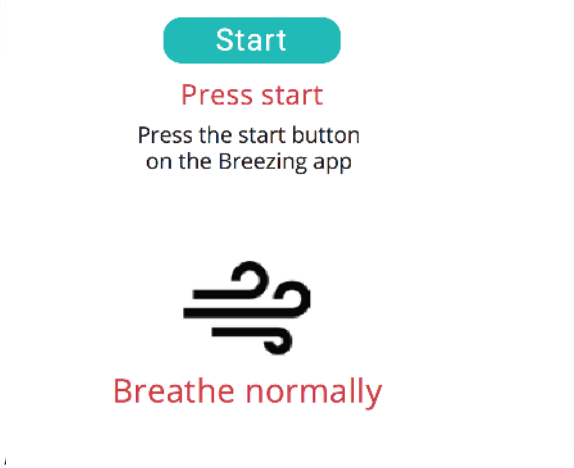
3. Making sure the sensor cartridge is correctly positioned to show the letter "B", insert it into the sensor slot.



4. Without attaching the disposable mask, place the Breezing Pro on a flat surface and wait until the app indicates it's ready to begin the measurement.

5. Attach the disposable mask to the Breezing Pro™ place it over the client's head, and start the measurement.

NOTE: 10 MIN COUNTDOWN



The measurement will only begin once the device detects a normal breathing pattern, and will continue until the testing time is completed.

Outline

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✓ **Pre-measurement – The professional's training:**
Device and App management

✓ **During the measurement – The professional's training:**
Conditions and Procedure

Post- measurement – The patient's education

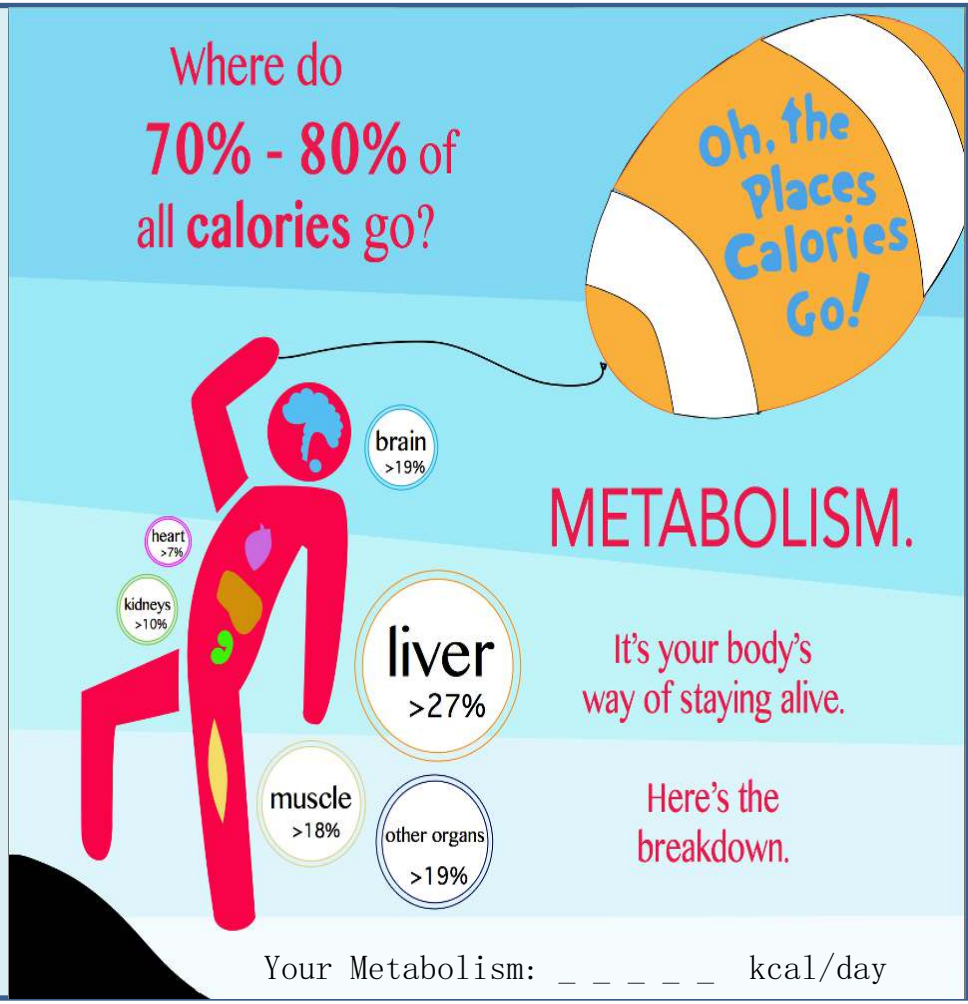
Weight drop and REE drop

Breezing Studies

Patient Plan Pamphlet

For any questions, contact us at:

_ _



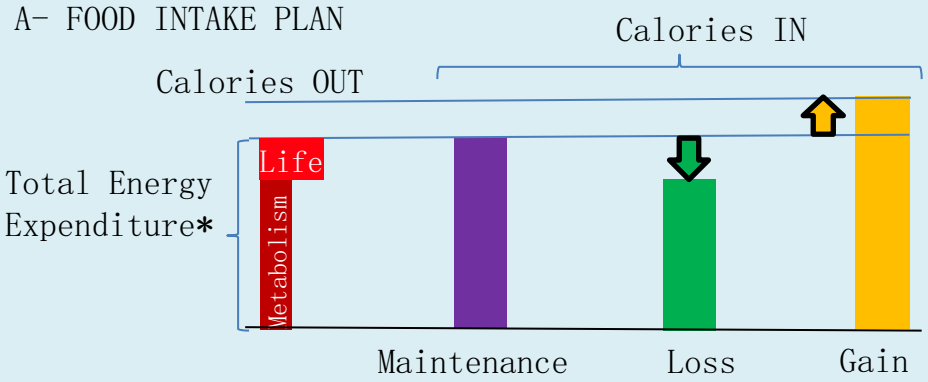
(back/front)

B

Patient Plan Pamphlet Cont.

The plan for you:

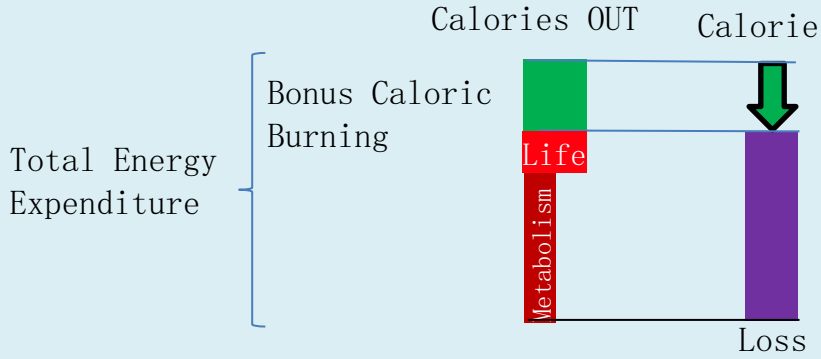
A- FOOD INTAKE PLAN



Planned Calories IN: _ _ _ _ _ _ _ _ _ _ _ _

*Life = work/house activities (sedentary, lightly active, etc.)

B- ACTIVITY/SUPPLEMENTATION PLAN



Planned Bonus Burning: _ _ _ _ _ _ _ _ _ _

_ _

C- HABITS PLAN

Current Sleep: _ _ _ hrs.

Sleep target: _ _ _ hrs.

Other:_ _ _ _ _ _ _ _ _ _ _ _

RECOMMENDED METABOLISM TRACKING

Initial 1 month | 6 months | 12 months

Next Appointment: _ _ _ _ _ _

(inside)

B

Outline

✓ **Indirect Calorimetry, and mobile device accuracy**

✓ **Pre-measurement - The patient's education and preparation**

✓ **Pre-measurement – The professional's training:**
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✓ **During the measurement – The professional's training:**
Conditions and Procedure

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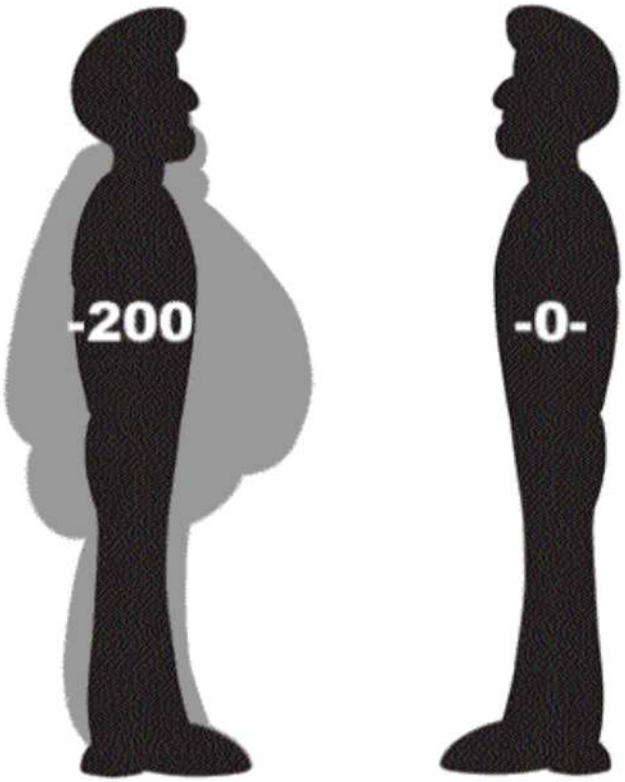
Weight drop and REE drop

Breezing Studies

Weight Drop and REE Drop: Metabolic Adaptation



"The more successful you are at losing weight, the slower your metabolism can be."

Dr. Kevin Hall, Ph.D.
Senior Investigator, National Institutes of Health, NIH.gov

"Persistent metabolic adaptation 6 years after The Biggest Loser competition"
E. Fothergill, J. Guo, L. Howard, J.C. Kerns, N.D. Knuth, R. Brychta, K.Y. Chen, M. C. Skarulis, M. Walter, P.J. Walter, and K.D. Hall*

Obesity (Silver Spring). 2016 Aug; 24(8): 1612–1619.

One example from the study: after losing 239 pounds, a participant's resting metabolism was 200 kcal/day than the expected for someone of his new size.
In other words, the participant has to eat 200 kcal/day less, or exercise 200 kcal/day more than his size-paired subject to maintain weight.

B

REE Drop Upon 5-10% Weight Loss

Sustained depression of the resting metabolic rate after massive weight loss[1-3]

Diane L Elliot, Linn Goldberg, Kerry S Kuehl, and William M Bennett

Am J Clin Nutr 1989;49:93–6.

TABLE 1
Subject characteristics before the protein-sparing modified fast and after weight loss during caloric maintenance*

	Prediet	4 wk postdiet	8 wk postdiet
Total weight (kg)	106 ± 25	77 ± 14†	79 ± 16
Fat-free weight (kg)	55 ± 8	50 ± 8†	53 ± 8‡
Fat (kg)	50 ± 18	27 ± 8†	27 ± 9
Percent fat (%)	47 ± 6	35 ± 5†	33 ± 5

* $\bar{x} \pm$ SD.
† $p < 0.001$ for 4 wk postdiet vs prediet.
‡ $p < 0.01$ for 8 wk postdiet vs 4 wk postdiet.

REE decreased after 4 weeks of negative energy balance (diet)

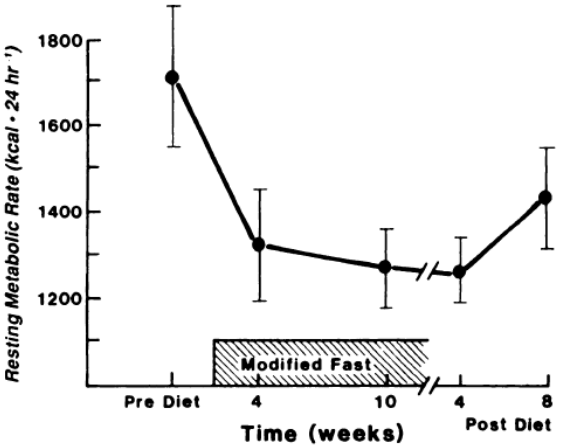


FIG 1. Changes in RMR (kcal·24 h^{-1}) observed in obese women before, during, and after a protein-sparing modified fast. The time effect is significant at $p < 0.001$ by ANOVA. ($\bar{x} \pm$ SEM.)

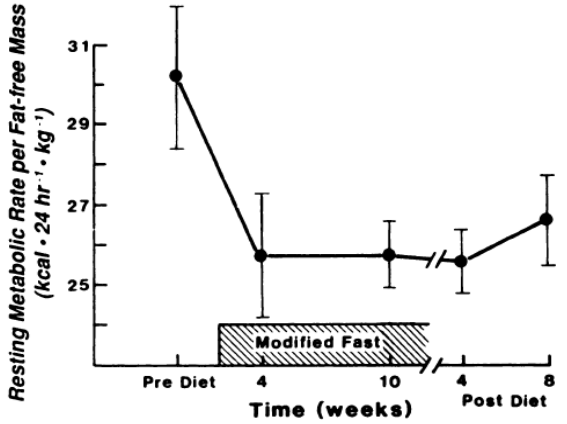


FIG 2. Changes in RMR per fat-free mass (kcal·24 $h^{-1} \cdot kg^{-1}$) observed in obese women before, during, and after a protein-sparing modified fast. The time effect is significant at $p < 0.01$ by ANOVA. ($\bar{x} \pm$ SEM.)

B

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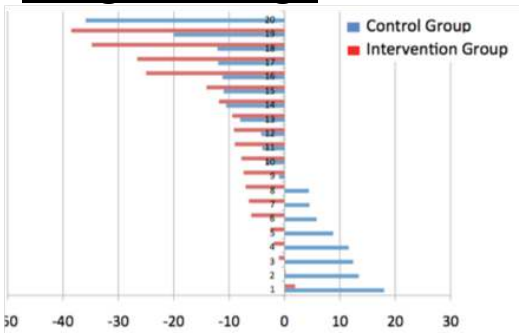
Breezing Studies

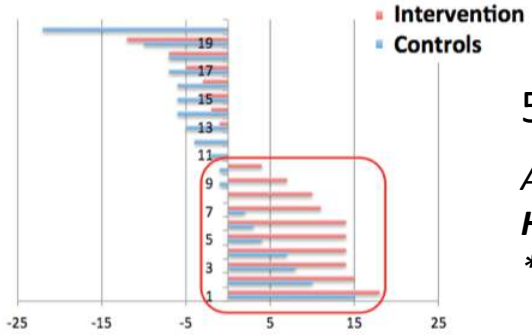
Metabolic Equations Don't Always Work

Weight Change



90% improvement in weight loss
5% weight gain vs. 40% in control
p = 0.01

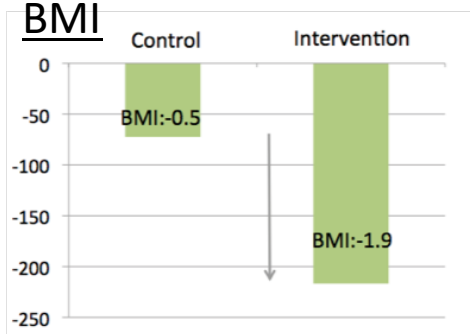
Blood Evaluation



5X improvement in HDL *(p = 0.04)*

*Also showed improvements in **glucose**, **HbA1C**, and **diastolic BP***
***Key variables in diabetes prevention*

BMI

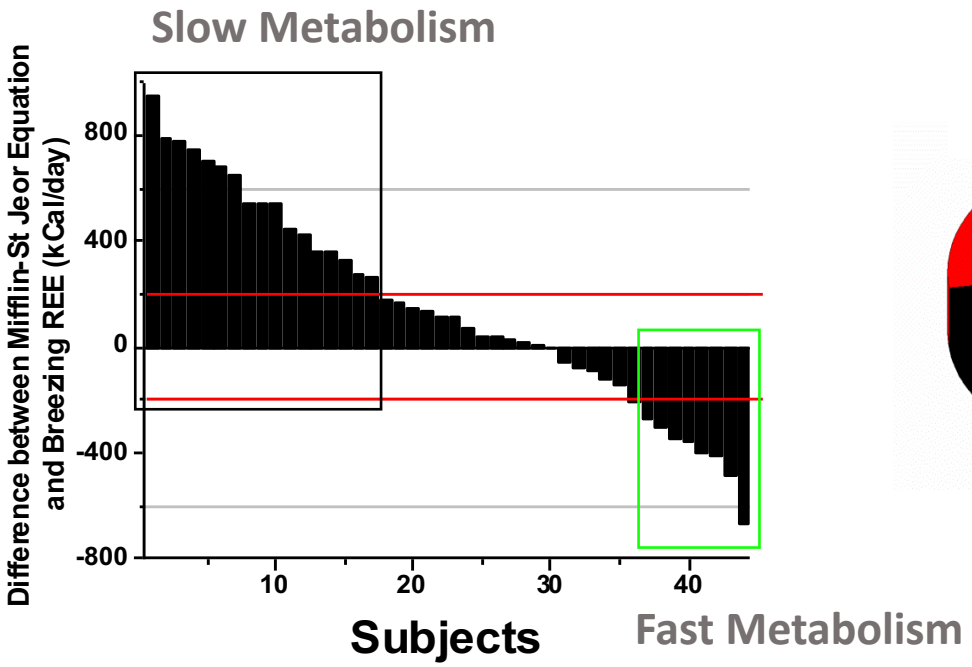


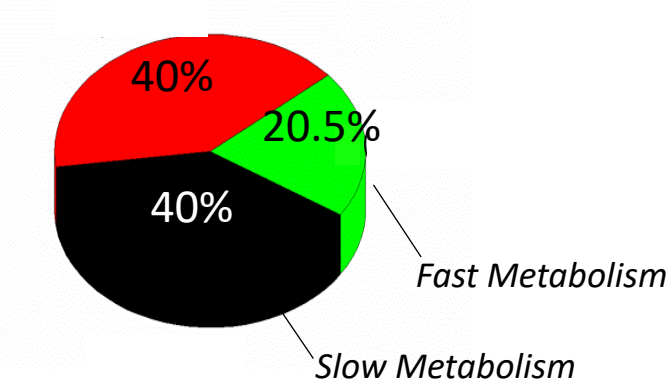
200% bigger BMI reduction BMI
(p=0.03)
70% more caloric intake tracking
(p=0.01)
25% more activity tracking

Breezing Pro used for REE measurement in study and showed a 40-90% error rate for metabolic formulas.

Stump C, Jackemeyer D, Abidov Y, Herbst K, Tao N, et al. (2017) Study of the Effect of Mobile Indirect Calorimeter on Weight Management. Glob J Obes Diabetes Metab Syndr 4(2): 044-050. DOI: http://doi.org/10.17352/2455-8583.000022

Metabolic Equations Don't Always Work

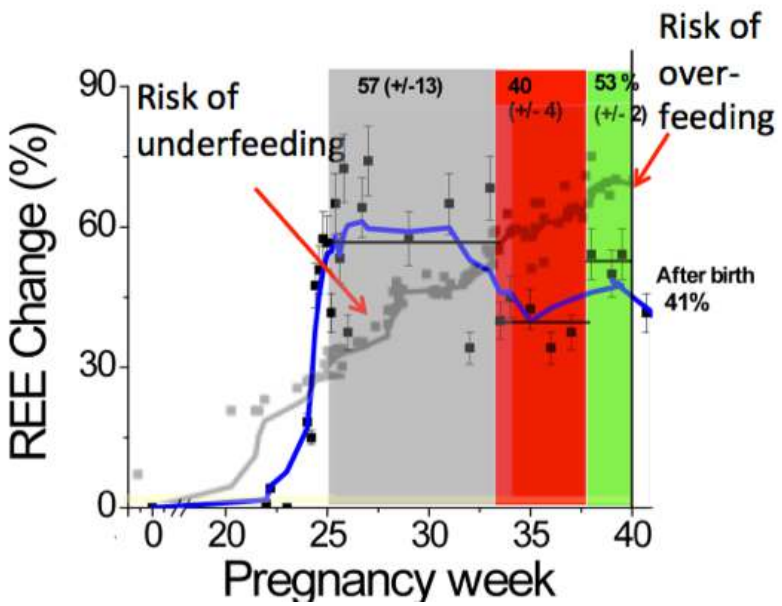


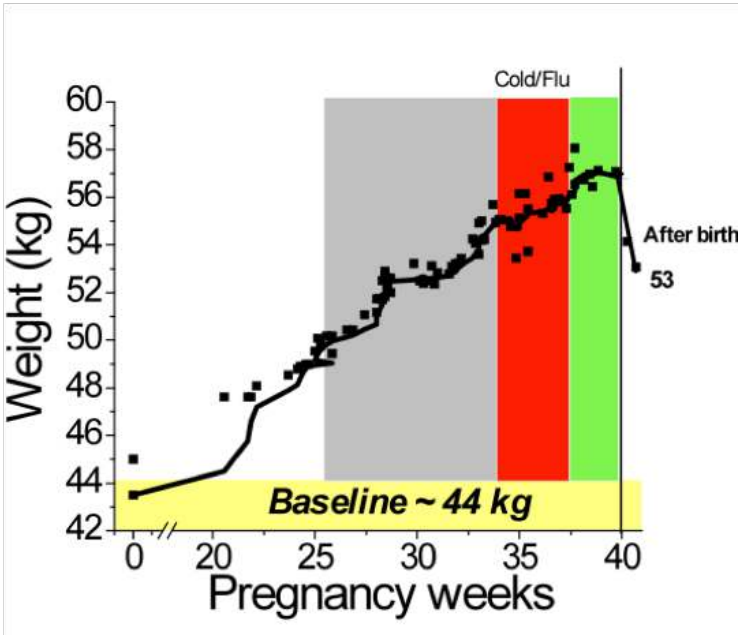


60% of the population does not follow metabolic equation values

Deng Y, Scott BJ (2019) Comparison of Resting Metabolic Rates: Calculated using predictive equation and measured using Portable Indirect Calorimeter. Glob J Obes Diabetes Metab Syndr 6(1): 010-016. DOI: 10.17352/2455-8583.000036

Metabolic Equations Don't Always Work





***Metabolism fluctuates significantly during pregnancy → REE cannot accurately be predicted**

Jackemeyer D, Forzani F, Whisner C (2017) Study of Resting Energy Expenditure and Weight Changes during Pregnancy. Glob J Obes Diabetes Metab Syndr 4(1): 016-023. DOI: http://doi.org/10.17352/2455-8583.000018

Most Recent Publication

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Gazzetta Medica Italiana - Archivio per le Scienze Mediche 2019 mese;178(0):000–000
DOI: 10.23736/S0393-3660.18.03945-1

ORIGINAL ARTICLE

Personal mobile tracking of resting and excess post-exercise oxygen consumption with a mobile indirect calorimeter

Xiaojun XIAN [1], Francis TSOW [1], Samita RAI [1], Troy ANDERSON [2], Amlendu PRABHAKAR [1], Mirna TERRERA [1], Barbara AINSWORTH [3], David JACKEMEYER [1], Ashley QUACH [1] *, Nongjian TAO [1, 4], Erica FORZANI [1, 5]*

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