

Abstract

Background--The purpose of this study was to assess the validity and reliability of the FitMate metabolic system (Cosmed, Rome, Italy) in measuring resting metabolic rate (RMR) in a heterogeneous group of adults. **Methods**--The FitMate is new, small (20 x 24 cm) metabolic analyzer designed for measurement of oxygen consumption and energy expenditure during rest and exercise. Subjects included 60 healthy adults (N=30 males, N=30 females) ranging in age from 19 to 65 years (mean±SD age, 36.9±13.4 years) and body mass index (BMI) from 19.2 to 44.8 kg/m² (27.7±6.2 years). Subjects were given two 10 min RMR tests during one test session during which RMR was measured simultaneously with the Douglas bag and FitMate systems. **Results**-- No significant differences were found



between Douglas bag and FitMate systems for oxygen consumption (242±49 and 240±49 ml/min, respectively, P=0.066, r=0.97, mean±SD absolute difference 2.83±11.68 ml/min) or RMR (1,662±340 and 1,668±344 kcal/day, P=0.579, r=0.97, mean±SD absolute difference 5.81±80.70 kcal/day). Standard error of estimates for oxygen consumption and RMR were 11.5 ml/min and 79.9 kcal/day, respectively. Test to test reliability correlation coefficients for oxygen consumption for the FitMate and Douglas bag systems were r=0.94 and r=0.95, respectively. The RMR difference between the Douglas bag and FitMate systems was not significantly correlated with BMI or the RMR average indicating no difference in RMR estimation between systems at the lower and higher BMI and RMR levels. **Conclusion**-- These data indicate that the

FitMate is a reliable and valid system for measuring oxygen consumption and RMR in adults.

Introduction

- Energy expenditure is commonly divided into three components: resting metabolic rate (RMR), physical activity, and thermogenesis induced by food intake, exposure to cold, and other stressors. Measurement of energy expenditure, in particular RMR, has improved our understanding of the pathophysiology of human obesity.
- The accurate assessment of RMR requires sophisticated methodologies including human calorimeters, closed circuit indirect calorimetry equipment, and open circuit indirect calorimetry equipment such as Douglas bags and gas analyzers, whole body respiratory chambers, and computerized metabolic carts using a variety of interfaces including mouthpieces, masks, and ventilated hoods. All of these methods are costly and cumbersome to conduct, require highly skilled technicians, and are impractical for most clinical and community settings.
- The estimation of RMR using equations induces substantial error, is not applicable to special populations, and can become impractical in clinical settings when FFM is included in the equation. For these reasons, the need exists for an inexpensive, easy-to-use, portable, and accurate device for measurement of resting energy expenditure in non-laboratory settings. Cosmed developed the FitMate to meet this need.

Methods

- The FitMate is new, small (20 x 24 cm) metabolic analyzer designed for measurement of oxygen consumption and energy expenditure during rest and exercise. It uses a turbine flowmeter for measuring ventilation, a galvanic fuel cell oxygen sensor for analyzing the fraction of oxygen in expired gases, and incorporates a patent pending innovative sampling technology that allows the FitMate to retain the performance of a metabolic cart with a standard mixing chamber. RMR is calculated from oxygen consumption, a fixed respiratory quotient (RQ) of 0.85, and estimated grams of urinary nitrogen using a modified Weir equation.
- Subjects included 60 healthy adults (N=30 males, N=30 females) ranging in age from 19 to 65 years (mean±SD age, 36.9±13.4 years) and body mass index (BMI) from 19.2 to 44.8 kg/m² (27.7±6.2 years).
- Subjects were given two 10 min RMR tests in one test session during which RMR was measured simultaneously with the Douglas bag and FitMate systems.

Result

- Sixty subjects (30 M; 30 F) completed all phases of the study. Subject characteristics are reported in Table 1. BMI did not differ between genders, and ranged from 19.2 to 44.8 kg/m², with 42% of subjects having a BMI <25 kg/m², 21% 25-29.9 kg/m², and 37% 30 kg/m².
- No difference was found between M and F for the primary outcome measures, and the data are presented for all subjects combined (Table 2; Figure 1).
- No significant differences were found between Douglas bag (DB) and FitMate systems for oxygen consumption (mean of both tests, 242±49 and 240±49 ml/min, respectively, P=0.066, r=0.97, mean±SD absolute difference 2.83±11.68 ml/min) or RMR (1,662±340 and 1,668±344 kcal/day, P=0.579, r=0.97, mean±SD absolute difference 5.81±80.70 kcal/day). SEE for oxygen consumption and RMR were 11.5 ml/min and 79.9 kcal/day, respectively. No differences were found between DB and FitMate for FeO₂ or VE (Table 2).
- FeCO₂, RER, and RR data are summarized in Table 2 for descriptive purposes but could not be compared between systems.
- Test to test reliability correlation coefficients for oxygen consumption for FitMate and DB were r=0.94 and r=0.95, respectively. The RMR difference between DB and FitMate was not correlated with BMI (r=0.12, P=0.180).
- A Bland-Altman plot was used to show the difference scores between methods (DB - FitMate) over the complete range of measured RMR (Figure 1). The RMR difference between the Douglas bag and FitMate systems was not significantly correlated with the RMR average (r=-0.04, P=0.375).

Table 1 Subject characteristics for male (n=30) and female (n=30) subjects (mean±SD).

Variable	Males	Females	P-value
Age (yrs)	33.9±13.4	39.8±12.9	0.089
Stature (m)	1.77±0.07	1.65±0.04	<0.001
Body mass (kg)	86.5±17.8	75.6±17.1	0.018
Body mass index (kg/m ²)	27.6±5.4	27.8±7.0	0.887

Table 2 Comparison of oxygen consumption (VO₂), resting metabolic rate (RMR), and other metabolic values between the FitMate and Douglas bag methods during 2 comparison tests (n=60 all subjects combined)

	Test 1	Test 2	P-Value
VO₂ (ml/min)			
FitMate	240±51	239±50	0.066
Douglas bag	242±48	243±51	
RMR (kcal/day)			
FitMate	1672±352	1665±345	0.579
Douglas bag	1654±333	1671±357	
FeO₂ (%)			
FitMate	16.8±0.6	16.9±0.6	0.178
Douglas bag	16.7±0.6	16.8±0.6	
Ventilation (l/min)			
FitMate	7.60±1.64	7.80±1.78	0.270
Douglas bag	7.51±1.58	7.78±1.78	
		Mean±SD	
FeCO₂ (%)			
Douglas bag	3.53±0.49	3.52±0.53	3.53±0.50
RER			
Douglas bag	0.78±0.05	0.81±0.05	0.80±0.05
RR (breaths/min)			
FitMate	12.7±3.6	12.4±3.8	12.5±3.6

Discussion/Conclusions

- These findings indicate that the FitMate gives accurate and reproducible oxygen consumption and RMR measurements for nonobese and obese, male and female individuals.
- Standard error of estimates for oxygen consumption and RMR were 11.5 ml/min and 79.9 kcal/day, respectively. These are lower than reported for other similar systems.
- These results support the use of the FitMate by health and fitness professionals for measuring RMR and providing individualized counseling in nutritional and weight management settings.

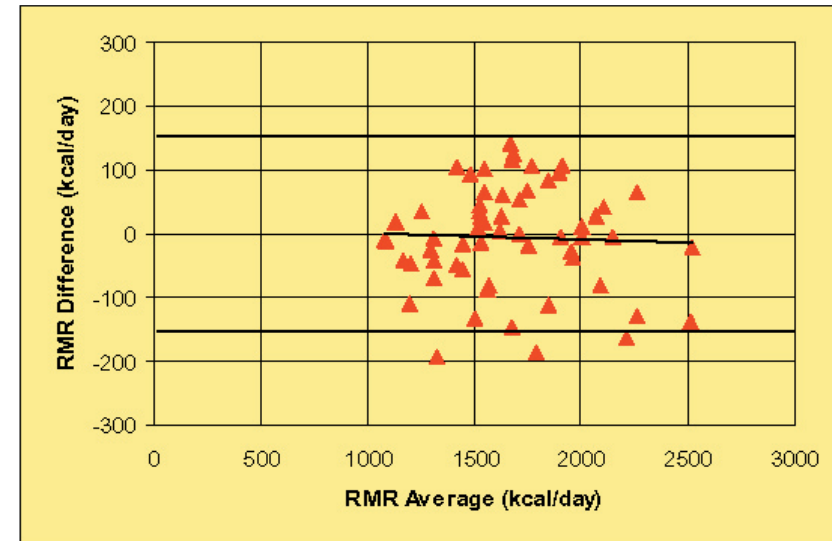


Figure 1 Bland-Altman plot depicting absolute differences in resting metabolic rate values between the Douglas bag and FitMate methods versus mean values (n=60). The solid lines depict plus and minus 2 SD from the mean difference (-5.81±80.7 kcal/day). The sloped line within the data represents the linear trend of the data.

