Validity of Fat-free Mass-based Prediction Equations for Estimating Resting Metabolic Rate in Muscular Resistance-trained Adults

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Introduction

- An individual's resting metabolic rate (RMR) is commonly the largest contributor (50-70%) to total daily energy expenditure.
- Furthermore, previous studies suggest a relationship between fat-free mass (FFM) and RMR, as fat-free mass may account for ~60-70% of RMR variation [1, 2].
- The accepted reference method for in vivo measurement of RMR is indirect calorimetry (IC).
- However, the accessibility of traditional IC analyzers is limited to select settings; therefore, prediction equations are also commonly applied to estimate RMR.
- Though many have evaluated the efficacy of select prediction equations for use in athletic populations, currently, there are limited data to inform the accuracy of common FFM-based prediction equations to estimate RMR in muscular resistance-trained adults [3].

Purpose

- The purpose of this study was to determine the validity of FFM-based RMR prediction equations for estimating RMR in muscular resistance-trained adults.

Methods

- A sample of 39 resistance-trained adults (16 F, 23 M; [mean ± SD] age 28.6 ± 7.9 y, height 171.8 ± 9.5 cm, weight 77.2 ± 12.9 kg, body fat% 17.3 ± 5.6, fat-free mass index 21.7 ± 2.9 kg/m2) (**Table 1**) underwent metabolic assessment via a metabolic cart (IC; Parvo Medics' TrueOne 2400) and body composition assessment via dual-energy X-ray absorptiometry (DXA) in a single visit (**Figure 1**).
- RMR estimates obtained from IC were considered the reference values.
- Three FFM-based prediction equations were also employed to estimate RMR.
- For the FFM component in these equations, FFM was calculated by subtracting total fat mass from total body mass estimated by the DXA device.
- Equivalence testing was used to evaluate whether any prediction equation demonstrated equivalence with IC.
- Null hypothesis significance testing was also performed, and Bland-Altman analysis was used alongside linear regression to assess the degree of proportional bias.
- Constant error (CE), mean absolute error (MAE), and 95% limits of agreement (LOA) were also calculated.

	All (n=39)		F (n=16)		M (n=23)	
	Mean	SD	Mean	SD	Mean	SD
Age (y)	28.6	7.9	28.9	8.6	28.3	7.6
Height (cm)	171.8	9.5	164.9	5.4	176.6	8.9
Body mass (kg)	77.2	12.9	66.0	5.8	85.0	10.6
Body fat (%)	17.3	5.6	22.8	3.2	13.5	3.3
Fat-free mass index (kg/m^2)	21.7	2.9	18.8	1.3	23.7	1.8

Table 1. Participant Characteristics

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Methods (cont.)

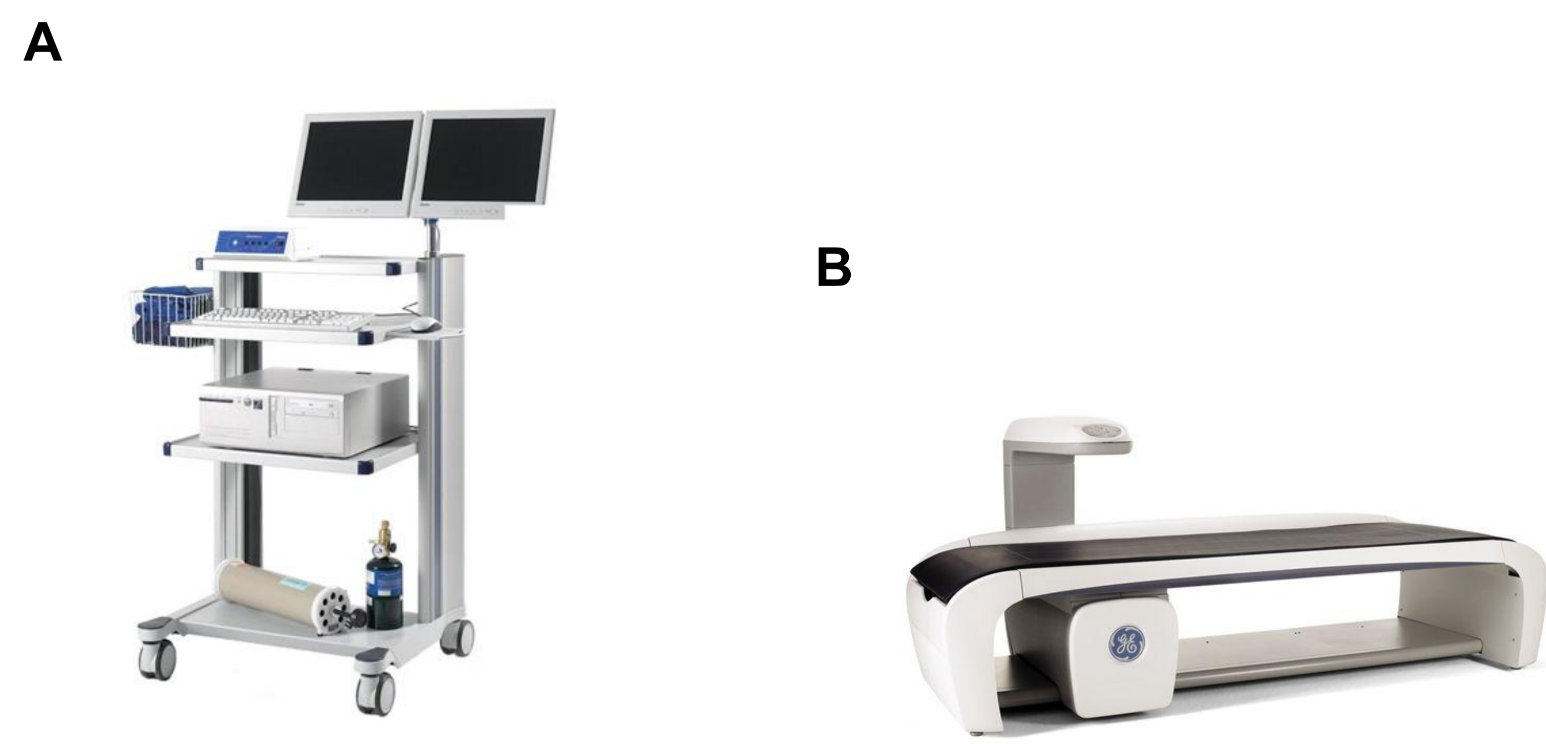

Figure 1: Metabolism and Body Composition Assessments. All participants underwent metabolic assessment via a metabolic cart (A) and body composition assessment via dual-energy X-ray absorptiometry (B). RMR estimates obtained from IC were considered the reference values. Three FFM-based prediction equations were also employed to estimate RMR.

Results

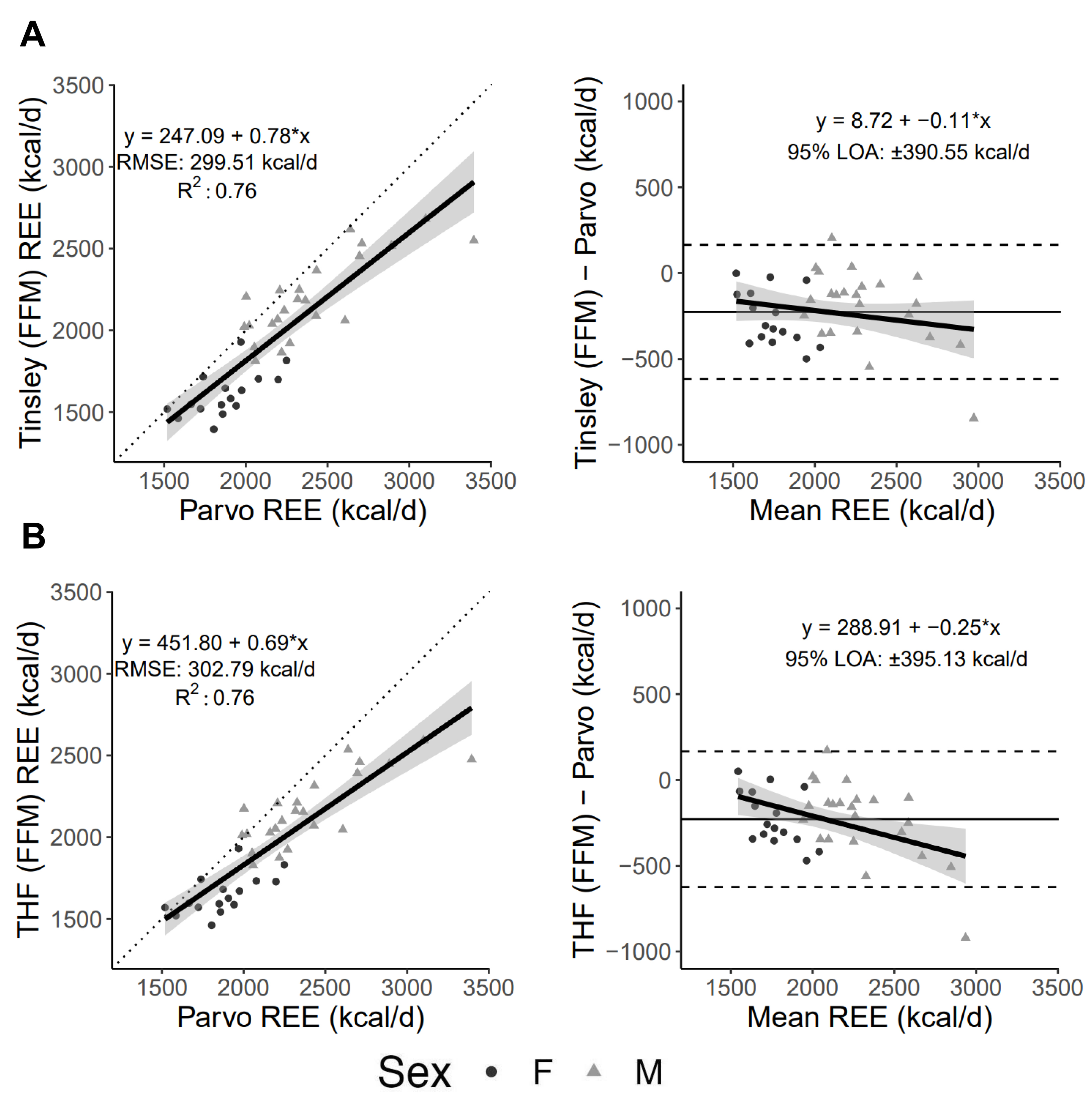

Figure 2: Line of Identity and Bland-Altman Plots for Estimating Resting Metabolic Rate. The left side of each panel depicts the observed linear relationship between the Tinsley FFM-based (A) and Ten Haaf and Weijs FFM-based (B) equations and IC, with the dashed line depicting the line of identity (i.e., a perfect relationship between methods). The right side of each panel depicts Bland-Altman plots, which display the observed agreement between the FFM-based equations and IC RMR.

Results (Cont.)

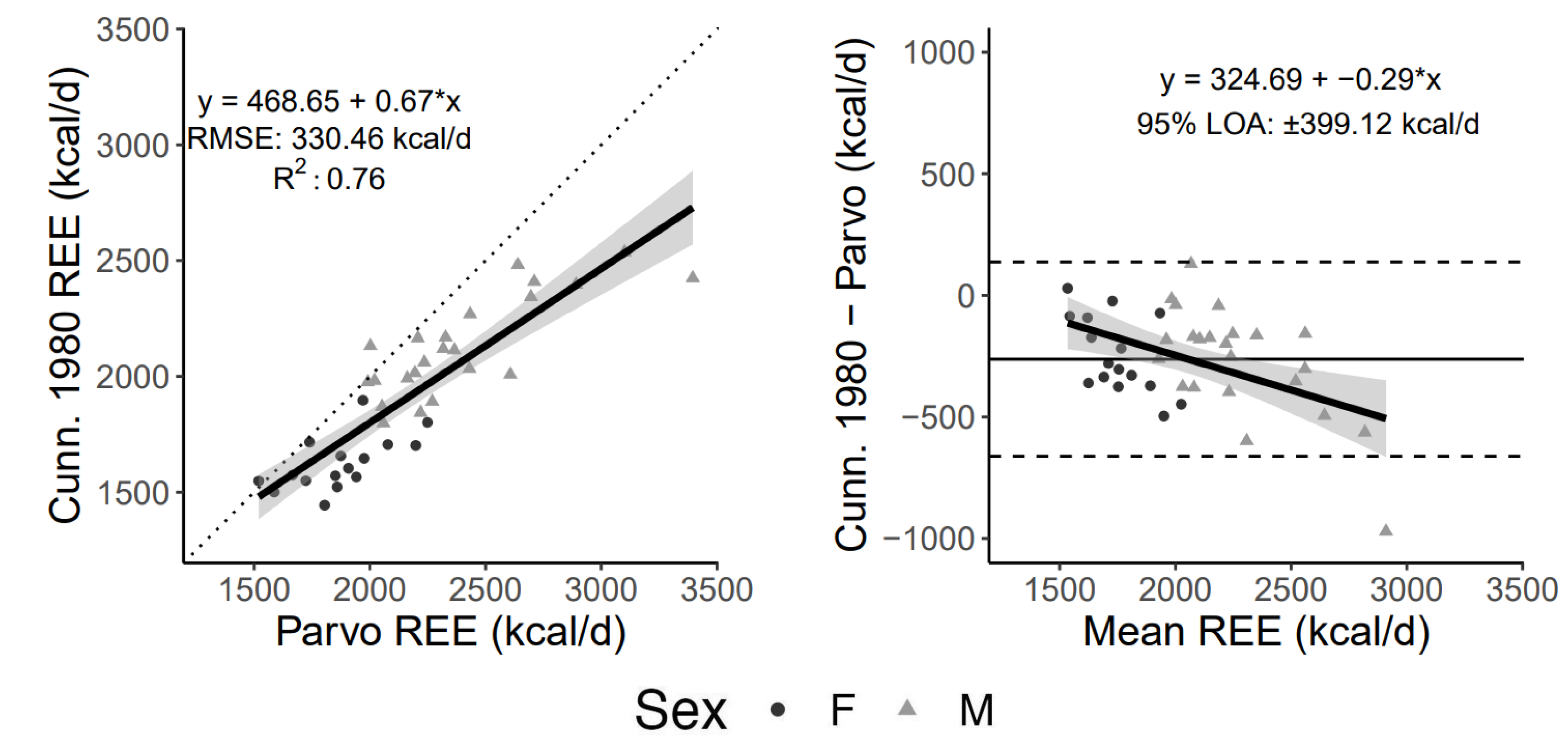

Figure 3: Line of Identity and Bland-Altman Plots for Estimating Resting Metabolic Rate with the Cunningham Equation. The left side depicts the observed linear relationship between the Cunningham FFM-based equation and IC, with the dashed line depicting the line of identity (i.e., a perfect relationship between methods). The right side depicts a Bland-Altman plot, which displays the observed agreement between Cunningham and IC RMR.

- The mean ± SD RMR estimate for IC was 2186.3 ± 405.4 kcal/d, while the estimates for the FFM-based equations ranged from 1924.0 ± 309.7 to 1960.4 ± 364.6 kcal/d.
- The CE and RMSE for the FFM-based equations ranged from -262.3 to -225.9 kcal/d and 299.5 to 330.5 kcal/d, respectively.
- Proportional bias was observed for two of the three equations, and wide LOA were present for all equations, ranging from 390.6 to 399.1 kcal/d **(Figure 2; Figure 3).**
- No prediction equation demonstrated equivalence with IC.

Conclusions

- In the present analysis, the consistent underestimation of RMR by the FFM-based equations indicate that they may not be suitable for application in muscular resistance-trained adults.
- While noteworthy, FFM contributes to a considerable portion of variance within RMR, and it has been suggested that the relationship between underprediction bias and RMR is likely a result of greater FFM [4].
- Therefore, though these equations included a FFM input, the weight of this input may not have been sufficient to fully account for the influence of FFM on RMR in this population.

Practical Applications

- Users should be aware of the potential for underestimation when applying these equations in practice. It is also critical that these equations be applied to populations like the one the equations were derived from.

References

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Acknowledgments

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