"Divide and conquer": assessing energy expenditure following physical activity type classification

J Appl Physiol 112: 932, 2012;
doi:10.1152/japplphysiol.01403.2011.

"Divide and conquer": assessing energy expenditure following physical activity type classification

Alberto G. Bonomi[1] and Guy Plasqui[2]

[1]*Personal Health Solutions, Philips Research Laboratories, Eindhoven; and* [2]*Human Biology department, Maastricht University, Maastricht, The Netherlands*

TO THE EDITOR: We read with interest the recent paper by Freedson et al. (3) on a well-conducted study to validate models for energy expenditure estimation and activity type identification based on a single Actigraph activity monitor. The study has great implications for understanding how to deploy physical activity data to extract relevant information on subjects' metabolic rate and activity behavior. In this letter we would like to express and justify our viewpoint on the methodology proposed by Freedson et al. (3) to achieve highly accurate energy expenditure estimations.

Although Freedson et al. (3) showed that a neural network provided unbiased MET estimates with a relatively low root mean squared error, the presented accuracy was similar to that obtained when the Crouter MET prediction equation (2) was applied to the same dataset. The Crouter method uses a simple thresholds-based classification scheme to distinguish between sedentary, lifestyle, and ambulatory activities, and for each activity group a certain linear equation converts activity counts to MET. Thus a simpler and more interpretable model offered a comparable MET estimation error to that obtained with the neural network. This is in line with the findings of a few recent studies showing the advantage of combining physical activity recognition to type-specific MET prediction equations for improving energy expenditure estimates (1, 4).

The activity classification method proposed by Freedson et al. (3) was developed to distinguish between household, ambulatory, and sport activities, but the outcome of the classification process was disregarded during the prediction of energy expenditure. In the paper, Freedson and colleagues express their concern about the reproducibility of the neural network MET estimation error for activities not included in the training dataset. This certainly represents a strong limitation of the proposed method, as it is highly impractical to gather data on body movement and energy expenditure for the majority of the human occupations that could occur in daily life. A more feasible alternative is represented by combining activity classification with activity-type specific estimations of energy expenditure, according to a "divide and conquer" strategy. Indeed, even complex and heterogeneous human occupations, often not considered in the development phase of a MET estimation model, could be divided and simplified as a series of basic movement, e.g. maintaining posture, ambulation, moving limbs. In this way, a system able to identify those basic activity types can break down the complexity and nonlinearity of the energy expenditure prediction problem. Thus once the relationship between basic activity types and energy expenditure is known, the prediction of the metabolic cost for the majority of the daily occupations can be achieved using activity classification and movement-specific MET estimates.

In conclusion, the neural network method failed to achieve substantial improvement in the assessment of energy expenditure because of the inability to predict MET for activity types not included in the dataset used to generate the model. Further steps toward achieving accurate MET estimations should be directed according to a "divide and conquer" strategy at combining activity classification and type-specific estimates of metabolic expenditure using accelerometer data.

Address for reprint requests and other correspondence: A. Bonomi, HTC 34, Eindhoven, The Netherlands 5656AE (e-mail: alberto.bonomi@philips.com).

AUTHOR CONTRIBUTIONS

Author contributions: A.G.B. drafted manuscript; A.G.B. and G.P. edited and revised manuscript; A.G.B. and G.P. approved final version of manuscript.

REFERENCES

1. **Bonomi AG, Plasqui G, Goris AH, Westerterp KR.** Improving assessment of daily energy expenditure by identifying types of physical activity with a single accelerometer. *J Appl Physiol* 107: 655–661, 2009.
2. **Crouter SE, Clowers KG, Bassett DR Jr.** A novel method for using accelerometer data to predict energy expenditure. *J Appl Physiol* 100: 1324–1331, 2006.
3. **Freedson PS, Lyden K, Kozey-Keadle S, Staudenmayer J.** Evaluation of artificial neural network algorithms for predicting METs and activity type from accelerometer data: validation on an independent sample. *J Appl Physiol* 111: 1804–1811, 2011.
4. **Sazonova N, Browning RC, Sazonov E.** Accurate prediction of energy expenditure using a shoe-based activity monitor. *Med Sci Sports Exercise* 43: 1312–1321, 2011.

