ACCELEROMETERS IN THE CONTEXT OF INTAKE-BALANCE ASSESSMENTS

FINDINGS, STRATEGIES, AND RESOURCES

Paul R. Hibbing, PhD
University of Illinois Chicago

UI Health | UIC

1

WHAT'S AHEAD

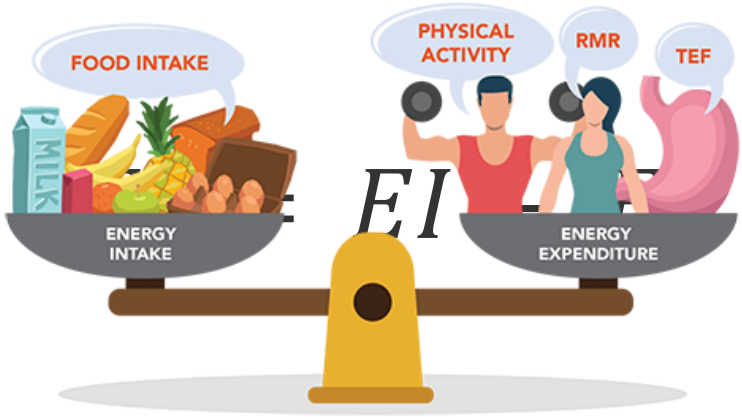
- Overview of the intake-balance method
- Intro to accelerometer-based intake-balance methods
  - Validation methods
  - Prior findings
- Strategies and resources for implementing accelerometer-based intake-balance methods

2

OVERVIEW OF THE INTAKE-BALANCE METHOD

3

WHAT IS THE INTAKE-BALANCE METHOD?



activehealth.sg

4

WHAT IS THE INTAKE-BALANCE METHOD?

stableisotope.tn-sanso.co.jp

deutramed.com

$$EI = \Delta ES + EE$$

ksimg.com

5

INTRO TO ACCELEROMETER-BASED INTAKE-BALANCE ASSESSMENTS

12

WEARABLES FOR INTAKE-BALANCE

$$EI = \Delta ES + EE$$

ksimg.com

13

WEARABLES FOR INTAKE-BALANCE

$$EI = \Delta ES + EE$$

ksimg.com

14

ACCELEROMETRY FOR INTAKE-BALANCE

British Journal of Nutrition (2023), 130, 344–352 doi:10.1017/S0007114522003312

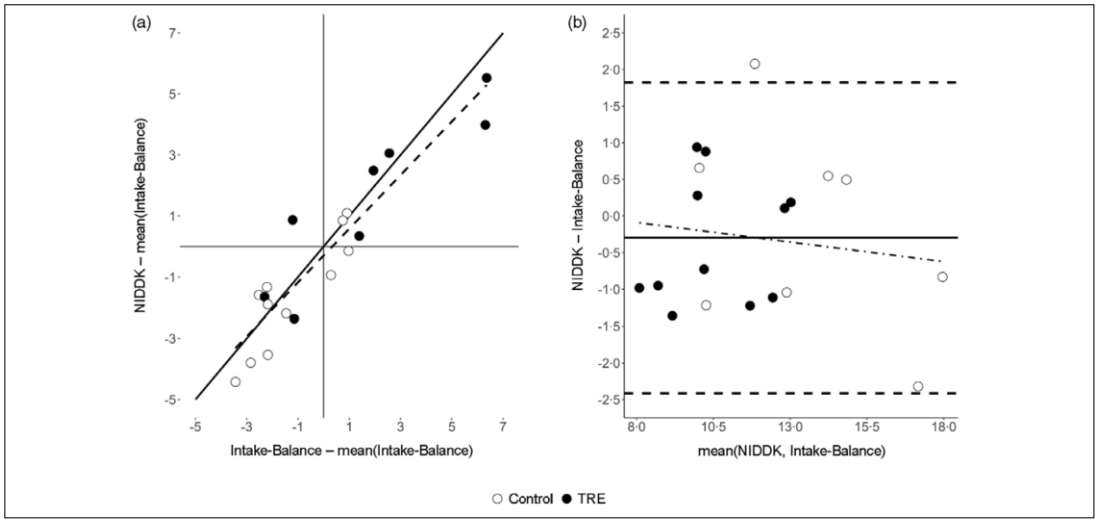
Predicting energy intake with an accelerometer-based intake-balance method

Paul R. Hibbing[1]*, Robin P. Shook[1,2], Satchidananda Panda[3], Emily N. C. Manoogian[3], Douglas G. Mashek[4] and Lisa S. Chow[4]

DOI: 10.1017/S0007114522003312

15

ACCELEROMETRY FOR INTAKE-BALANCE

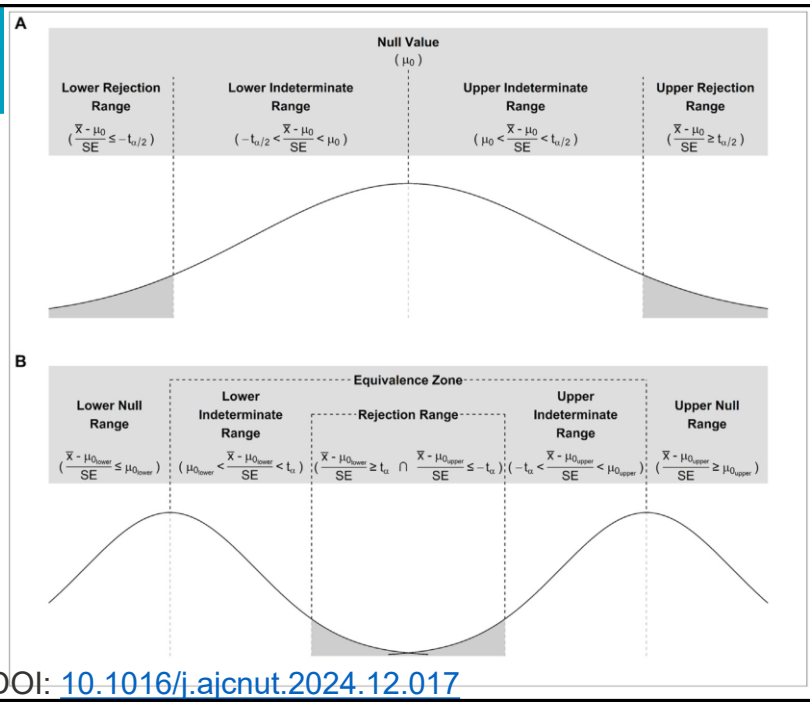


DOI: 10.1017/S0007114522003312

16

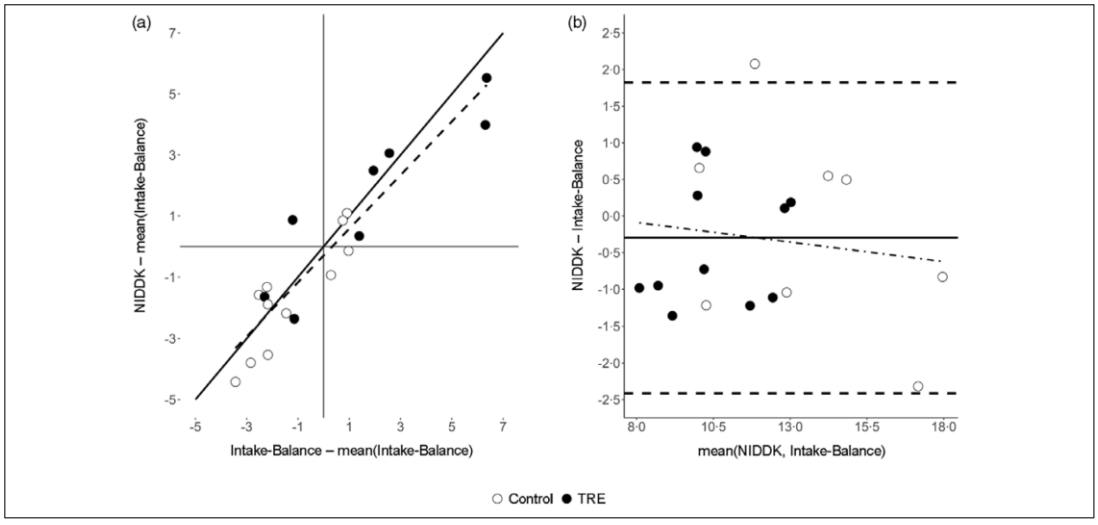

Wawa®
NOT TREATED
WITH rBST*
*No significant difference has been shown between milk derived from rBST-treated and non-rBST-treated cows.

17



DOI: 10.1016/j.ajcnut.2024.12.017

18



DOI: 10.1017/S0007114522003312

19

Hibbing *et al. Int J Behav Nutr Phys Act* (2023) 20:115
https://doi.org/10.1186/s12966-023-01515-0

International Journal of Behavioral Nutrition and Physical Activity

METHODOLOGY Open Access

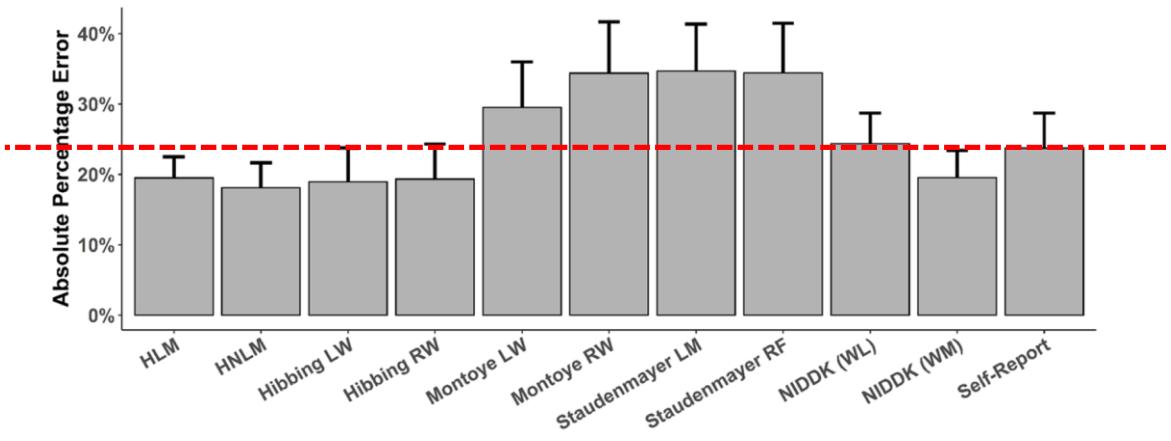
Criterion validity of wrist accelerometry for assessing energy intake via the intake-balance technique

Paul R. Hibbing[1,2*], Gregory J. Welk[3], Daniel Ries[4], Hung-Wen Yeh[5,6] and Robin P. Shook[2,6]

DOI: 10.1186/s12966-023-01515-0

20

ACCELEROMETRY FOR INTAKE-BALANCE



DOI: 10.1186/s12966-023-01515-0

21

BIGGER PICTURE

- Accelerometer methods can be improved over time
- Accelerometers can measure and record continuously

22

STRATEGIES & RESOURCES

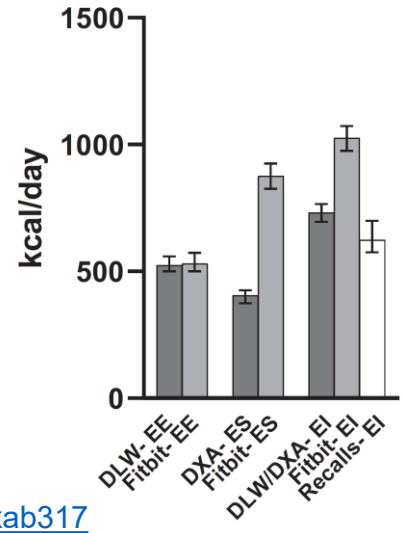
24

CONSUMER-GRADE TECHNOLOGY

$$EI = \Delta ES + EE$$

25

CONSUMER-GRADE TECHNOLOGY



DOI: 10.1093/jn/nxab317

26

RESEARCH-GRADE (ACCELEROMETER) TECHNOLOGY: ROADMAP

- (Choose a device and protocol; collect data)
- Pick and apply an EE algorithm
  - https://sites.google.com/view/accelerometerrepository
- Account for non-wear time (and sleep?)
- Determine final EE
- Then proceed to ES data and calculation of EI

29

TWO VIGNETTES

- paulhibbing.com/TREaccel (basic)
- paulhibbing.com/IntakeBalance (enhanced)

30

APPLYING EE ALGORITHMS

- Read files into R
  - Helpful packages: read.gt3x, GENEAread, GGIRread, AGread
- Pre-process data (format it according to algorithm's demands), apply the algorithm, and (if applicable) post-process the data, e.g., by averaging estimates every minute
  - For a number of algorithms, this can be done in one big step using the accelEE package

31

ACCOUNTING FOR NON-WEAR

- Run a non-wear detection algorithm
  - Useful packages are PhysicalActivity (Choi algorithm) and GGIR
  - Ahmadi et al. have also tested some useful algorithms for raw acceleration
- Overlay non-wear data on EE data, and exclude EE estimates from non-wear periods
- If desired, use imputation to compensate for the lost data (e.g., by assigning resting EE to non-wear periods as a conservative measure)
  - The PAutilities package has functions to estimate basal/resting EE using, e.g., Harris-Benedict and Schofield equations, etc.

32

DETERMINE FINAL EE

Date	total_minutes	total_hildebrand_linear	total_is_Sleep	total_is_NonWear
9/18/2019	1440	2.536927	828	490
9/19/2019	1440	2.512302	816	500

33

CALCULATING EI

PID	fm_start	fm_end	ffm_start	ffm_end	ee	n_days
001	50.5	50.7	75.1	74.9	1950	14
002	70.2	70.0	90.3	90.3	2473	14

Now let's calculate EI:

```
## Generate the result
df_result <- IntakeBalance::IntakeBalance(

  ## These arguments still refer to the same information outlined previously,
  ## but now we have added a layer of abstraction to reference the names of
  ## columns where that information is stored, rather than providing the
  ## values themselves
  fm_start = "fm_start",
  fm_end = "fm_end",
  ffm_start = "ffm_start",
  ffm_end = "ffm_end",
  ee_per_day = "ee",
  n_days = "n_days",

  ## The trick is to pass in a data frame via this extra argument. That's how R
  ## knows to interpret the other variables as column names rather than raw values
  df = info

)

## Show the result
knitr::kable(df_result)
```

PID	fm_start	fm_end	ffm_start	ffm_end	ee	n_days	delta_ES	EI
001	50.5	50.7	75.1	74.9	1950	14	121.1429	2071.143
002	70.2	70.0	90.3	90.3	2473	14	-135.7143	2337.286

34

ZOOMING BACK OUT

- (Choose a device and protocol; collect data)
- Pick and apply an EE algorithm
  - https://sites.google.com/view/accelerometerrepository
- Account for non-wear time (and sleep?)
- Determine final EE
- Then proceed to ES data and calculation of EI

35

CONCLUSION

- Accelerometer-based intake-balance methods are one of several ways to assess EI, and suitability may vary by study
- Limitations apply
- Teamwork advised
- Lots of questions still to be answered!

36

THANK YOU

37