The Value of Self-Report Dietary Data: Challenges Related to Data Collection, Analysis, and Interpretation

2016 ILSI Annual Meeting

Amy F. Subar, PhD, MPH, RD
US National Cancer Institute
Risk Factor Methods Branch

Hello from snowy Maryland!

Outline

- Recent criticisms of self-report dietary data
- Overview of measurement error
- Accuracy of absolute energy intake based on self-report
- Magnitude of underreporting: energy vs. other nutrients
- Implications of measurement error
- Recommendations regarding data collection, analysis, and interpretation
- Conclusions

Recent criticisms of self-report dietary data

- Based on **energy** "underreporting," dietary self-report data have no value

Validity of U.S. Nutritional Surveillance: National Health and Nutrition Examination Survey Caloric Energy Intake Data, 1971–2010

Edward Archer

Published: October

Implausible results in human nutrition research

BMJ 2013 ; 347 doi: http://dx.doi.org/10.1136/bmj.f6698 (Published 14 November 2013)

Cite th

Medical News & Perspectives | November 27, 2013

Do Flawed Data on Caloric Intake From NHANES Present Problems for Researchers and Policy Makers?

Mike Mitka, MSJ

International Journal of Obesity (2015) **39,** 1109–1113; doi:10.1038/ijo.2014.199; published online 23 December 2014

Energy balance measurement: when something is not better than nothing

Archer E, et al. PloS One 2013;8(10):e76632. doi: 10.1371/journal.pone.0076632. | Mitka M. JAMA 2013;310(20):2137-8. | Ioannidis JP. BMJ 2013;347:f6698. doi: 10.1136/bmj.f6698. | Dhurandhar NV, et al. International Journal of Obesity 2014. doi: 10.1038/ijo.2014.199. | Archer E, et al. Mayo Clin Proc. 2015;90:911-26

Popular press quotes

The Scientist » News & Opinion » Opinion

Opinion: A Wolf in Sheep's Clothing

Nutrition research must overcome pseudoscientific measures and self-interest to make progress in the fight against obesity.

By Edward Archer | October 22, 2013

So what is going on? Is such research mere pseudoscience? And if so, how can the federal government continue to spend billions of taxpayer dollars on studies that are making no demonstrable progress in our nation's fight against obesity and diabetes?

techniques are invalid implies that the field has been perpetrating fraud against the US taxpayers for more than 40 years—far greater than any fraud perpetrated in the private sector (e.g., the Enron and Madoff scandals).

NationalJournal

"To say they [the data] are imperfect is the equivalent of saying the *Titanic* had a floatation problem or a buoyancy problem. These data should not be used," says Edward Archer, an obesity researcher, who authored a scientific takedown of the NHANES data in the Journal *PLOS One*.

Measurement error

- Difference between the observed or measured value and the true value
  - Random error: inherent in all measures
  - Systematic error: biggest issue, causes erroneous findings
- Does systematic error in self-report dietary data render them useless?
- Do other self-report data lead to valuable findings?
  - Smoking history and physical activity related to multiple health outcomes
  - Folate and neural tube defects
- Error exists in clinical/laboratory data as well

Measurement error: Sources in self-report data

- Within-person variation
  - Easily adjusted with repeat applications and modeling
- Memory, depending on method
- Food and nutrient databases
- Default recipes and portion sizes
- Systematic bias: Misreporting based on individual characteristics

Energy intake is inaccurately estimated by self-report

- This major criticism is TRUE
  - Based on DLW and estimated energy requirements compared to self-report
- Must be widely acknowledged
- This systematic error varies by:
  - Instrument
  - Population characteristics

Potential sources of energy misreporting: Food frequency questionnaires

- Never intended to measure energy
- Finite list of foods and beverages
- Limited specificity
- Food database represents composites

Potential sources of energy misreporting: 24-hour recalls

- Memory issues
- Difficulty in estimating quantity

Potential sources of energy misreporting: Food records

- Reactivity
- Difficulty in estimating quantity (depends on methods)
- Memory, if not completed in real time

Summary: Why we have energy misreporting

- Limitations ofeach instrument
- Social desirability
- Social environment that stigmatizes obesity
- Energy is in nearly every food
  - Small and large errors add up
  - Energy intake errors likely larger in magnitude that for other nutrients and food groups

- Bottom line: Data have flaws that require thoughtful analysis and interpretation

Nutrition community acknowledges its measurement error problem

- Ongoing research since the 1970s
- Acknowledgement of limitations of self-report
- Progress to mitigate it:
  - Appropriate study design
  - Selection of number and types of instruments
  - Statistical methods to reduce error
  - Recommendations regarding interpretation of findings

Magnitude of the underreporting

- Validation Studies Pooling Project (VSPP)
  - Combined data from four of the largest recovery biomarker studies ever conducted in the US
  - All had DLW, multiple 24-urines
  - Energy, protein, potassium, sodium
  - FFQs and 24HRs

Freedman LS et al. Am J Epidemiol 2015;doi: 10.1093/aje/kwu325
Freedman LS et al. . Am J Epidemiol 2014;180:172-88.

Magnitude of underreporting

- Energy underreporting:
  - FFQs: 24-33%
  - 24HRs:
    - 6-16% for young and middle aged adults
    - 25% for elderly women
- Underreporting of other nutrients
  - 24HRs:
    - 5% protein
    - 3% potassium
- Controlled feeding study
  - Reported vs. known intakes not different for foods and nutrients

Kirkpatrick et al.. Am J Clin Nutr 2014;100:233-40

Recent claims regarding error in NHANES

- Archer et al., 2013
  - 67.3% women and 58.7% men reported energy intakes so low as to be physiologically implausible
- Briefel et al., 1997
  - 27.7% women and 18.1% men were severe under-reporters

- How did this happen?
  - Use of different cut points for Goldberg method
  - Archer used the wrong cut point at the individual level

Archer E, et al. PloS One 2013;8(10):e76632. doi: 10.1371/journal.pone.0076632
Briefel et al. Am J Clin Nutr. 1997 Apr;65(4 Suppl):1203S-9S.

Recent claims regarding error in US surveillance data

- Archer et al.:
  - Generated a flurry of media reports
- Refutations:
  - Subar
  - Hebert
  - Satija
  - Potter
  - Davy

Subar et al. J Nutr 2015:doi: 10.3945/jn.115.21964.
Hebert JR et al. Advances in nutrition. 2014 Jul;5(4):447-55
Satija A et al. Advances in nutrition. 2015 Jan;6(1):5-18.
Potter JD. Cancer Epidemiol Biomarkers Prev. 2015 Feb;24(2):323-30.
Davy BM and Estabrooks PA. Mayo Clin Proc http://dx.doi.org/10.1016/j.mayocp.2015.05.009

Implications of error: Surveillance

- Energy collected from 24HRs
  - Energy distributions shifted left
  - Persons above or below cut points affected
  - Correction for bias must consider population subgroups (BMI, education, etc.)
  - Biased and difficult to interpret
  - DLW would be optimal but often impractical

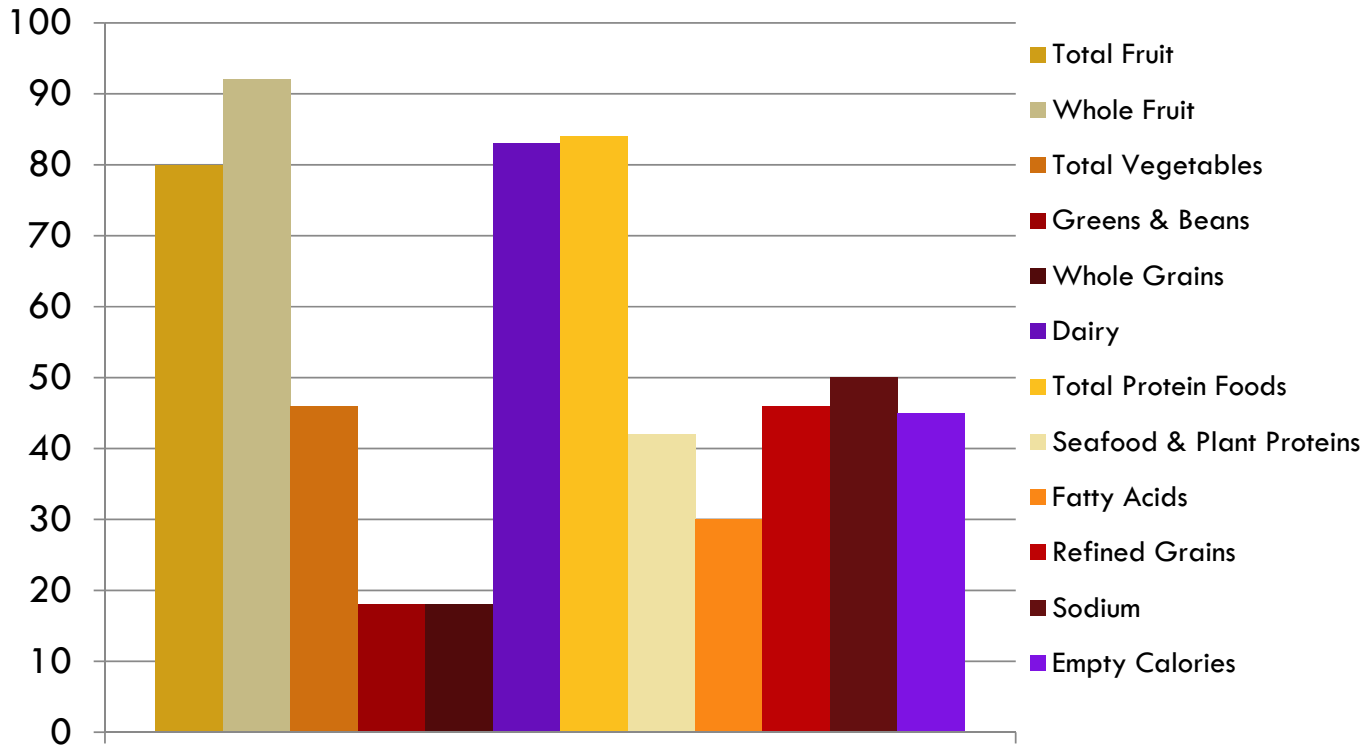
Implications of error: Surveillance

- Assessment of energy balance
  - Intake and expenditure both difficult to measure from self-report or even monitors
  - Weight and waist circumference over time or controlled feeding studies are better measures

Implications of error: Surveillance

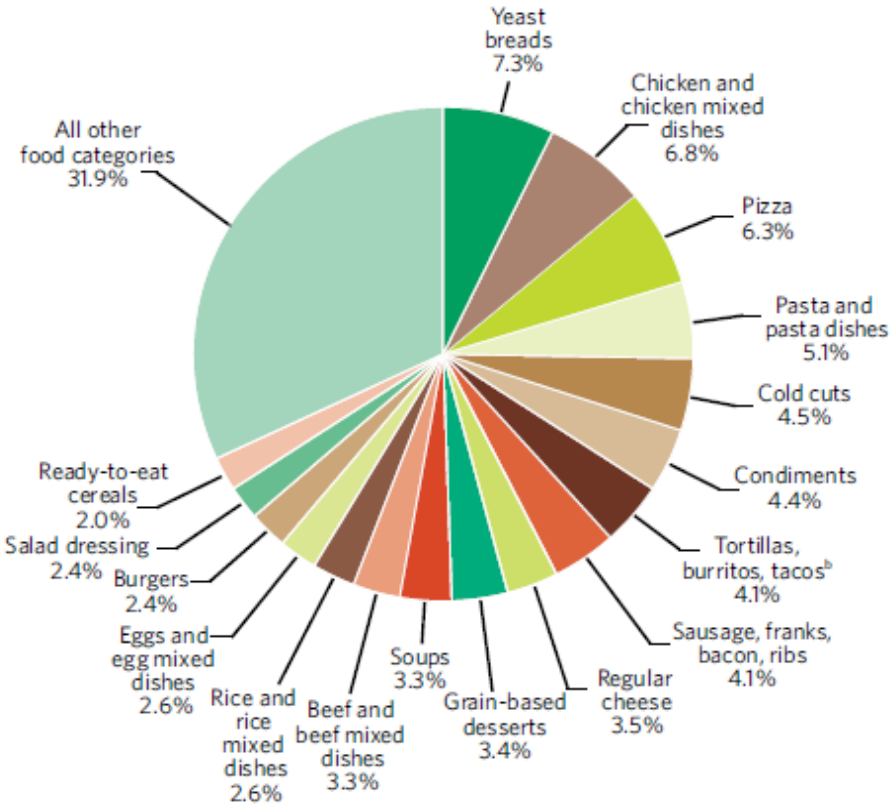
- Valuable data for obesity related questions
  - Types of foods consumed
  - Contextual factors (when and with whom eaten)
  - Assessment of nutrient adequacy
  - Assessment of nutrient or food group quality
    - e.g. intake/1000 kcal as in the Healthy Eating Index

What is the quality of children's diets as measured by HEI-2010?



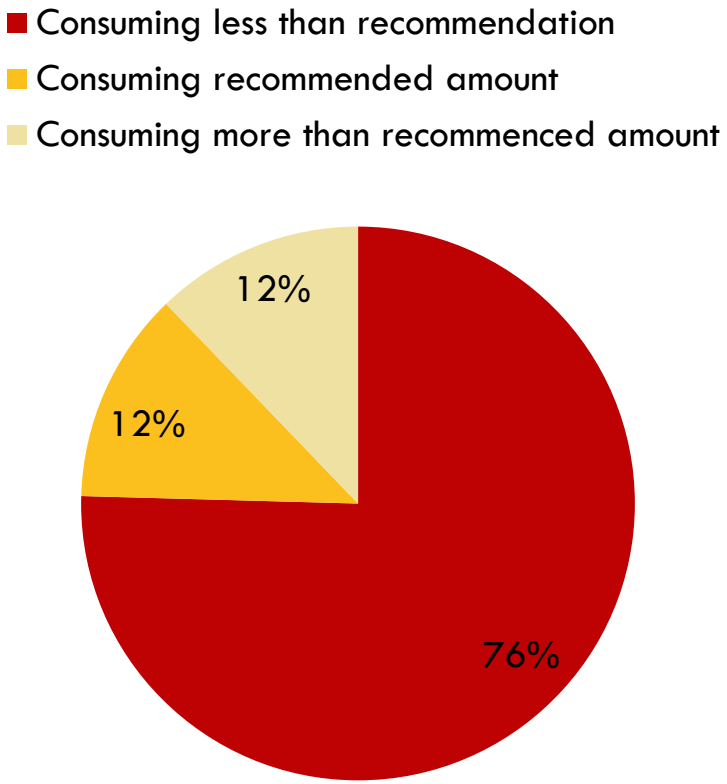
NHANES 2007-08, children ages 2-17

What are major sources of sodium in diets of US population?



NHANES 2005-06, ages 2 and older

What percentage of persons eats less than recommended intake of fruits?



http://appliedresearch.cancer.gov/diet/usualintakes/pop/2007-10/; NHANES 2007-2010, total population age 1+

Implications of error: Surveillance

- Valuable insights from surveillance data
  - Added sugar consumption far exceeds recommendations
  - Overall diet quality not consistent with Dietary Guidelines
- To the extent that bias exists
  - Less underreporting of fruits
  - More underreporting of sugar
  - So, it is likely worse than what we are measuring
- Data are valuable
  - Corrective action
  - Nutrition policy

Implications of error: Epidemiology

- Collect recovery biomarker when possible (in at least a subset) to do measurement error adjustment
- Do not use absolute energy as an exposure variable
- Collect DLW to correct for energy in self-report
- Do not use DLW to energy adjust other nutrients and food groups -- use self-reported energy
- In multivariate models of disease risk: control for self-reported energy
  - Reduces bias
  - Do not use energy coefficients to make inferences

Implications of error: Epidemiology

- If an association is found:
  - Error likely means associations are underestimated
  - Residual confounding can occur -- does not usually lead to spurious findings
  - Strong signal across studies likely to be true
  - FFQs most likely to fail to detect important associations, especially if small

Carcinogenicity of consumption of red and processed meat

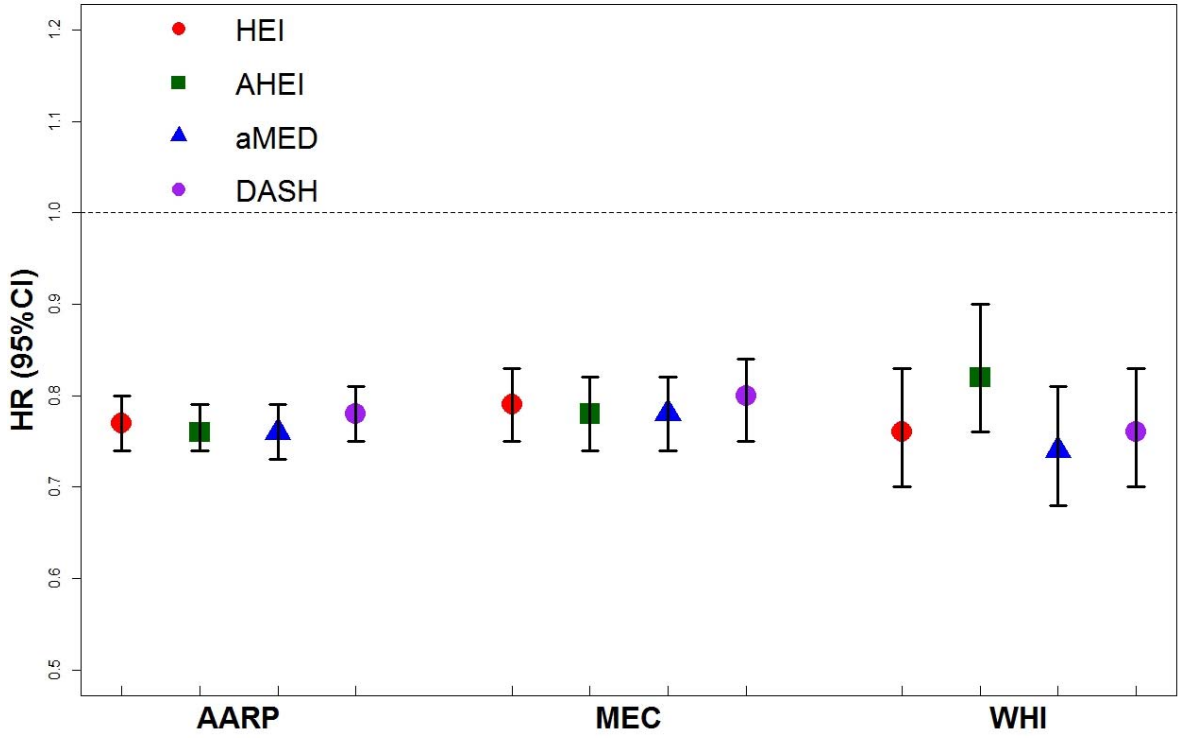
Véronique Bouvard, Dana Loomis, Kathryn Z Guyton, Yann Grosse, Fatiha El Ghissassi, Lamia Benbrahim-Tallaa, Neela Guha, Heidi Mattock, Kurt Straif

The Lancet Oncology
Volume 16, Issue 16, Pages 1599-1600 (December 2015)
DOI: 10.1016/S1470-2045(15)00444-1

Meat and cancer

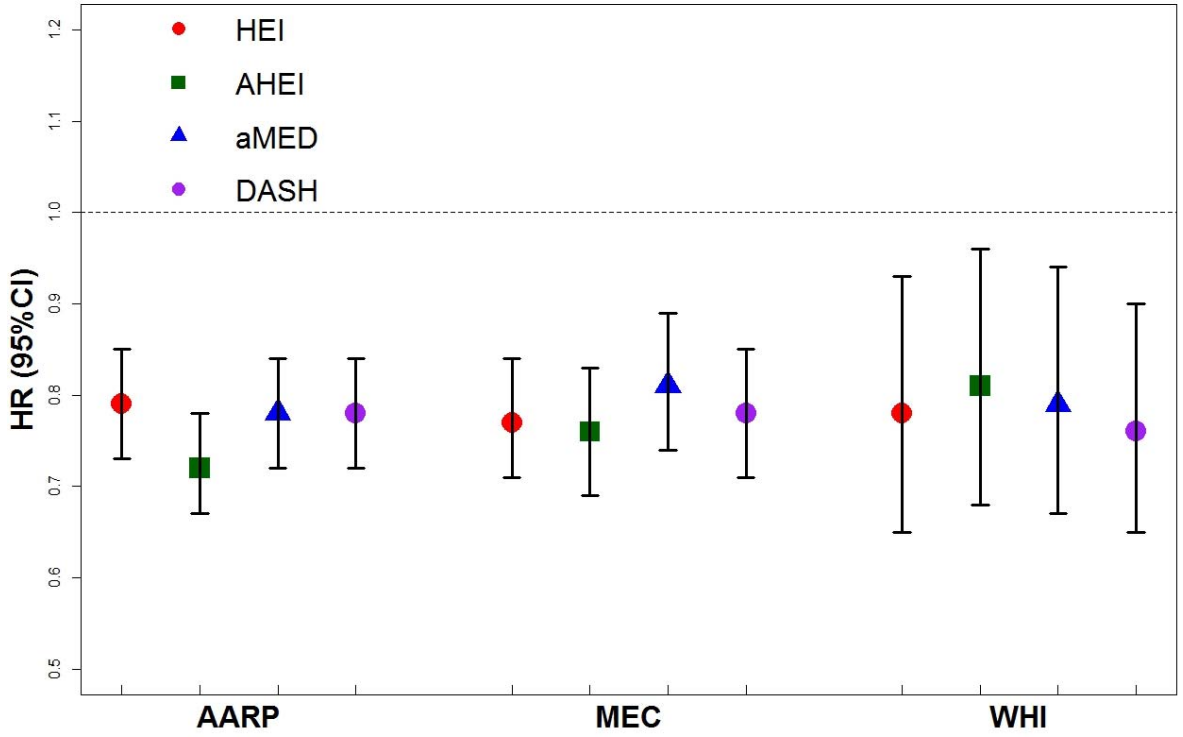
*"The Working Group assessed **more than 800 epidemiological studies** that investigated the association of cancer with consumption of red meat or processed meat in many countries, from several continents, with diverse ethnicities and diets. For the evaluation, the greatest weight was given to prospective cohort studies done in the general population. High quality population-based case-control studies provided additional evidence…"*

Dietary index-specific comparison of HRs of all-cause mortality across cohorts (women)



* Models adjusted for age, race, education, BMI, physical activity, smoking, energy, diabetes, alcohol (HEI/DASH), HRT (women); Comparing Q5 vs. Q1: HEI = Healthy Eating Index-2010, AHEI = Alternate Healthy Eating Index-2010; aMED = Fung's Mediterranean Diet Score; DASH = Fung's Dietary Approaches to Stop Hypertension Score

Dietary index-specific comparison of HRs of CVD mortality across cohorts (women)



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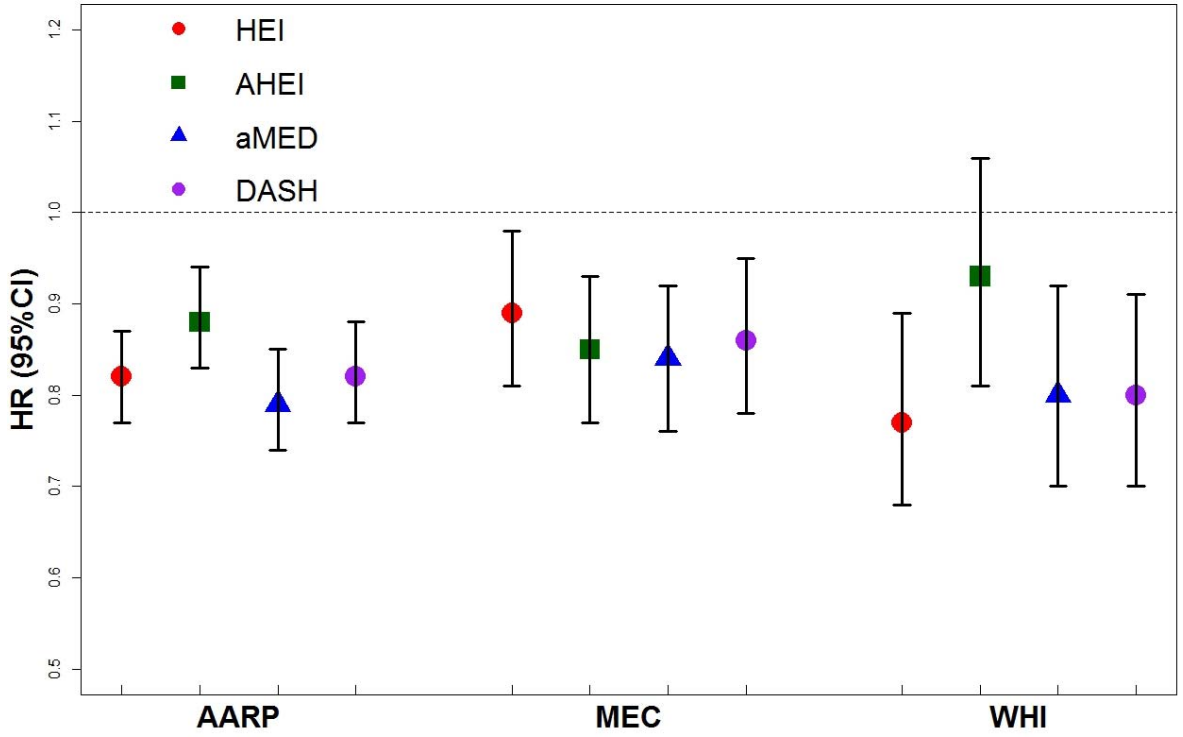
Dietary index-specific comparison of HRs of cancer mortality across cohorts (women)

Liese A et al. J Nutr 2015;doi:10.3945/jn.114.205336.



* Models adjusted for age, race, education, BMI, physical activity, smoking, energy, diabetes, alcohol (HEI/DASH), HRT (women); Comparing Q5 vs. Q1: HEI = Healthy Eating Index-2010, AHEI = Alternate Healthy Eating Index-2010; aMED = Fung's Mediterranean Diet Score; DASH = Fung's Dietary Approaches to Stop Hypertension Score

Recommendations for data collection, analysis and interpretation

- Improve tools
  - Technology may help
- Combine dietary assessment methods if possible
- For energy, consider administering DLW
- Research more affordable methods to accurately measure energy intake and expenditure
  - Self-report still useful for patterns, diet quality, etc.
- Thoughtfully interpret data

Carol RJ et al. Am J Epidemiol 2012;175:340-47.

Recommendations for data collection, analysis and interpretation: Surveillance

- To improve estimates of mean intakes and distributions of energy for surveillance:
  - Collect DLW in at least a subset to adjust for error in energy intake estimates
- Continue to collect 24-hour recalls

Recommendations for data collection, analysis and interpretation: Epidemiology

- Begin using recalls or record as primary tool vs. food frequency questionnaires
  - Technology makes this feasible
  - Recalls and records less biased and culturally neutral
- Combining methods: use FFQ data for covariate information
- If FFQ is primary instrument:
  - Include calibration/validation substudies and do measurement error adjustment

Conclusions

1) Continue to collect self-report dietary intake data for surveillance and epidemiology
2) Do not use self-reported energy intake as a measure of energy intake
3) Do use self-reported energy intake for energy adjustment of other self-reported dietary constituents to improve risk estimation
4) Acknowledge the limitations of self-report dietary data; analyze and interpret them appropriately

Conclusions

5) Design studies and conduct analyses that allow adjustment for measurement error
6) Design new epidemiological studies to collect data from both short- and long-term instruments on everyone
7) Continue to develop, evaluate, and further expand methods including biomarkers and new technologies

Please don’t…

Questions?

Thank you!