Comments on Health Behavior Scores

Background

- Many studies look for magic bullets
- Red meat meta analysis done at TAMU
  - No statisticians experienced with nutrition, i.e., me
  - Non-significant effect, and interpretation that red meat is just fine for you
  - Harvard goes berserk
- WHI clinical trial emphasizing saturated fat
  - last big dietary clinical trial
  - P-value 0.07, many, may millions of $$

Background

- The only thing that is consistent is the lack of reproducibility in epi studies
- It is usually one food/nutrient at a time
- But nutrition is highly multivariate
- I think one at a time studies (epi or clinical trials) are just silly
- Nutritionists' idea is to get a score of healthy diets

Background

- There are many scoring systems for dietary intakes, with different aims
  - Healthy Eating Index (2005, 2010, 2015)
  - Alternative Healthy Eating Index
  - Dot-Dash scores
  - Mediterranean Diet Scores
  - World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) scores
  - .etc

Background

- They give consistent results across many studies (the Pooling Project)
- That is my point

Epi and Index Systems

- The basic idea of these scores is to create them based on literature research
- **Emphasize**: ONE scoring system, many forms of diets
- Once developed, they are then applied to a host of diseases and populations (e.g., men and women, smokers vs nonsmokers, etc.)
- Here is the HEI-2005 scoring system

Healthy Eating Index—2005

THE HEALTHY EATING INDEX (HEI) is a measure of diet quality that assesses conformance to Federal dietary guidance. The original HEI was created by the U.S. Department of Agriculture (USDA) in 1995. Release of new Dietary Guidelines for Americans in 2005 motivated a revision of the HEI. The food group standards are based on the recommendations found in My Pyramid (see Britten *et al.*, *Journal of Nutrition Education and Behavior* 38(6S) S78-S92). The standards were created using a density approach, that is, they are expressed as a percent of calorie or per 1,000 calories. The components of the HEI-2005 and the scoring standards are shown below.

Health Eating Index–2005 component and standards for scoring

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
Total Fruit (includes 100% juice)	5	≥0.8 cup equiv. per 1,000 kcal	No Fruit
Whole Fruit (not juice)	5	≥0.4 cup equiv. per 1,000 kcal	No Whole Fruit
Total Vegetables	5	≥1.1 cup equiv. per 1,000 kcal	No Vegetables
Dark Green and Orange Vegetables and Legumes	5	≥0.4 cup equiv. per 1,000 kcal	No Dark Green or Orange Vegetables or Legumes
Total Grains	5	≥3.0 oz equiv. per 1,000 kcal	No Grains
Whole Grains	5	≥1.5 oz equiv. per 1,000 kcal	No Whole Grains
Milk	10	≥1.3 cup equiv. per 1,000 kcal	No Milk
Meat and Beans	10	≥2.5 oz equiv. per 1,000 kcal	No Meat or Beans
Oils	10	≥12 grams per 1,000 kcal	No Oil
Saturated Fat	10	≤7% of energy	≥15% of energy
Sodium	10	≤0.7 gram per 1,000 kcal	≥2.0 grams per 1,000 kcal
Calories from Solid Fats, Alcoholic beverages, and Added Sugars (SoFAAS)	20	≤20% of energy	≥50% of energy

Global Index Systems

- Crucially, these index systems are to be used across many diseases and mortality outcomes
- They are popular in nutrition because they score the complex nature of dietary intakes
- Multiple patterns of intake have much the same risks of various cancers or other chronic diseases
- Nutritionists (Good ones anyway) do not think that there is only 1 magic diet (kale ☹)

Global Index Systems

- Dietary scoring systems recognize, for example, that there is not a 1-to-1 relationship between cancers and dietary patterns

Global Index Systems

- Diet scores are traditionally built on literature review and expert knowledge

Global Index Systems

- Two of my statistical papers on diet:
  - Ma, et al, JASA, 2007
    - Using data to create the scores
    - Based on single index models
    - Easy in the case that the SIM is linear
  - Kravitz and Carroll, STAT, 2020
    - Applying some sort of model selection criterion to ask what dietary components actually matter
    - Empty calories?

Global Index Systems

- Physical Activity scores
- Uses AARP data and a physical activity questionnaire (no wearable device data in the study)
- Keadle, et al, MSSE 2020
- The AARP Study is of people aged 50-75, so not many do a lot of vigorous PA

Global Index Systems

- The scores for the best activity sums to 100
- At least for mortality, PAQ has a much stronger signal than dietary observations
- We used data and a R package called scar (smooth constrained additive regression)
- Nonparametric MLE with shape constraints

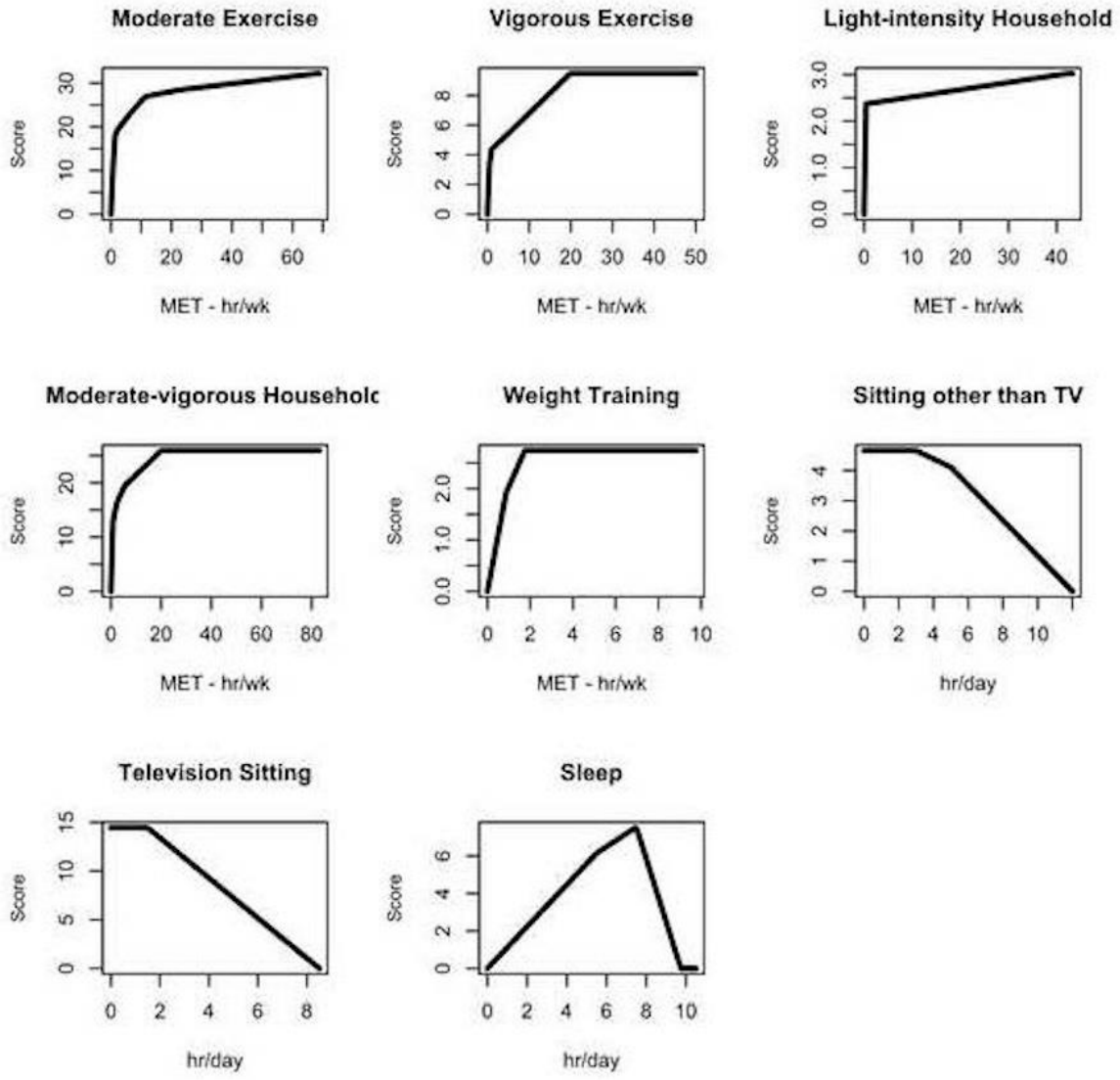
Global Index Systems

- We used scar on the AARP PAQ
- The functions are piecewise linear
- The R package scam does the same thing, but more smoothly.

Global Index Systems

- Maximum scores
  - Moderate PA: 30
  - Mod-Vig Household: 25
  - No television: 15
  - Vig: 10
  - 8 hours sleep: 8
  - Non-TV sitting: 5
  - Light-intensity household: 4
  - Weight training: 3

Global Index Systems



Global Index Systems

- Clearly AARP is a special study
- It only has self-report
- I want to do it for accelerometers, across multiple studies
- Ciprian, his colleagues and I have started a research project to do so

General Idea

- The main conceptual issue is to buy into the idea that you want a **single scoring system** that applies across multiple populations
- Nutrition has bought into this in a big way
- While they do not express this technically, they know that there is no 1-to-1 function of dietary intakes that best predicts multiple diseases
- Jill Reedy and others at NCI

Under the Hood

- The basic idea, for mortality say
- You have a collection of variables for PA, sedentary and sleep: call them X
- You have demographic and other risk factors that would be in any analysis, Z
- You have an outcome, such a mortality, Y
- Your have say 2 populations to work with, men and women, k=1,2

Under the Hood

- In the simplest format, for k = 1,2, you seek a function S such that

$$\mathrm{pr}(Y_k = 1 | X_k, Z_k) = H\{\beta_{0k} + S^T(X_k, \theta)\beta_{xk} + Z_k^T \beta_{zk}\}$$

- The scoring system is $S(X_k, \theta)$
- **Crucially**, it does not depend on k, the population
- It codifies practice: build a score, apply to different populations
- Obvious to extend to different diseases

Under the Hood

- Model $\mathrm{pr}(Y_k = 1 | X_k, Z_k) = H\{\beta_{0k} + S^T(X_k, \theta)\beta_{xk} + Z_k^T\beta_{zk}\}$

- There are obvious model identification issues, but they are merely technical (I do technical ☺)

- There are obvious questions about how to form

$$S(X_k, \theta)$$

- Fine, fun challenge, but need to keep it simple