Slide

1.

2.

3. “fatal flaw of obesity research”

lack of physical activity is linked to obesity, first physical activity guidelines stipulated by federal government, but we should know whether people adhere to these guidelines or not. This could have implications for policy

4.

5. first law of thermodynamics, change in energy stores refers to changes in body composition

energy balance provides an alternative way to measure EI, which is typically very difficult and clouded with measurement error and within person variability, gold standard and cheap, objective measures exist for both EE and ES. Gold standard is DXA and DLW. To the best of our knowledge, no one has modeled energy balance measurement error

6. There is clearly relationships between EE, ES, EI, so modeling energy balance instead of just one component can make model more useful and powerful. People in the obesity research field already use energy balance in their mathematical models, but “even with DLW and DXA measurements, the relationship doesn’t hold and its suspected this is due to measurement error and biological variation” -Diana Thomas

7. followed individuals for a year, and get 5 measurements of a lot of stuff every 3 months. Only the gold standard measure of ES, no replciation on gold standard DLW. Don’t technically have replicates, but will use this data to help build a measurement error model for energy balance. Talk about using these for diagnostics like normality

8. Diagnostic for checking distribution of measurement errors given by Carroll.

9. We suspect that cheaper devices measuring EE and ES have biases involved in their measurements and formulas. For the subset of individuals who received DLW, we ran the multiple regression, even though the armband and DLW are measuring the same thing, other covariates still seem to be important. Could mean device is biased by certain demographic factors. We are also making an assumption that the relationship is linear

10. For our purposes, we will have units in avg kcal/day, because DLW gives estimate over course of 2 weeks, we want to keep units consistent. We don’t need to specify exactly which cheap measurement we’re using (so long as its not self-report) as any instrument can be modeled in the general framework we’re presenting. Usual can be thought of as 2-3 year average

11. give justification for assuming conditional independence

12. same model as what we fit with EBS data, don’t expect estimates for gamma to be biased, but slope on W is not true relationship between y and x. sigma2 includes measurement error and within person variability

13. measurement error model. Make distributional assumption about latent variables (joint)

14.

13. We are in the somewhat unusual situation where our Y variable isn’t a health outcome, but is another measurement (surrogate) of the latent variable.

14. There have been similar uses of B-splines and p-splines in measurement error problems to allow flexibility in relationships between outcome variables and latent variables, however all of them have a predetermined number of knots at fixed locations, often just specify a large number of knots (15+). This selection could have an effect on the outcome. By using free knot splines, we let the data speak for itself and place knots accordingly. We also get to put a prior on the number of knots, helping us control the flexibility of the model, in our case, we don’t anticipate the need for many knots

15. Need splines to be monotone in order to take inverse later on to calibrate. We add this flexibility to our previous LMEM, otherwise everything else stays the same. Kee and kes are the number of knots which are treated as random variables

16. To improve the flexibility of modeling the bivariate latent variables, we propose placing a DPM prior on them. Use stick breaking representation. Set value of alpha to 1.

17. naïve and LMEM are programmed in JAGS and this algorithm is for SMEM programmed in C++ and R. present the gibbs algorithm for SMEMN here as for SMEMDP is in the writeup. Priors were chosen for conjugacy as much as possible, no conjugacy can be attained for X, so we use a metropolis within gibbs step. We use a random walk with a bivariate normal proposal, where the covariance matrix of the proposal is adaptively tuned during burn in.

18. updating the spline parameters is listed as one step here, I’ll discuss this step in detail further. Ree res are the locations of the knots, also random variables.

19. RJMCMC introduced to allow sampler to jump between parameter spaces as a way for model determination. In our case, it will be used to allow the number and location of knots to change. There are a variety of RJMCMC algorithms for free knot splines. We choose Denison because it is easy to implement and it is effective compared to more complicated (ie full Bayesian approach by DiMatteo). Although DiMatteo provides a fully Bayesian approach, he also provides an adjustment to Denison’s likelihood ratio, (which because it uses the plug-in OLS estimator),by using the BIC instead, which improves performance and compares similarly on smooth functions. Fully bayes performs better on highly complex functions. The spline being a latent variable causes problems. If we reject a proposal, we keep the current coefficients, but update the s(x) using new basis matrix for new x. We also have the possibility of having a knot outside the bounds of our X. This could happen if a current knot is at a value of x near the min or max, and after the x’s are updated, that knot is now bigger or smaller than the max or min. To avoid this issue, we don’t allow the min 3 or max 3 values of x to be knots. This is fine because we don’t want the model to be too flexible at the tails anyway. We also have a linear component in our mean function that we need to take care of. Since the algorithm is the same for EE and ES, we omit subsripts

20. Prior for number of knots we choose to be a poisson, for knot locations discrete uniform with current x as possibilities as chosen by Dension. This choice helps simplify the sampler, and in our case isn’t a big deal since the x’s change every iteration anyway. C controls the rate at which move types which change dimension are proposed, between 0 and 0.5, we take it to be 0.4 like Denison

21. We are doing OLS on the basis matrix constructed from current x and current knots, plus the linear model matrix

22. To assess the performance of our model and check some of the modeling assumptions, we performed a simulation study under the following…issues with DP when only 2 replicates, acceptance probabilities were weird for X and parameter estimates unstable even when running chain longer, stable for 4 replicates, also tried with 3 and estimates stable, acceptance rates were sometimes weird

Add one at this point

24.

26. given a cheap measurement y of EE or ES, we want to be able to calibrate it based on our fitted spline and linear regression coefficients to reduce bias and measurement error. We choose R random draws from the posterior, Because we can’t analytically take the inverse of s, we do it numerically with optimize.

27. calibration moves closer to truth. Doing this for many individuals, typically the only time the calibration makes it worse is when the observed and truth are very close to begin with, and calibration only makes it negligibly worse. Doesn’t occur often

28. As a proof of concept and pilot study for larger grant in the future for modeling Energy Balance, we will be collecting data (recently received IRB approval) with assistance from Kinesiology department here (Laura Ellingson, Greg Welk), Robin, and some of his resources.

29.

30.

31. What we are interested in modeling is the number of minutes in MVPA occurring in at least 10 minute bouts. A MET is metabolic equivalent of task, and is a way of expressing the energy cost of physical activities. 1 MET is the energy equivalent of someone seated at rest. METs than compare physical activity to seated at rest, a MET of 3 is… Moderate Physical Activity is 3-6 METs (walking 3mph, light biking), Vigorous is 6+ (jogging, jump rope). So the guidelines leave some room for interpretation.

32. The SWA gives minute by minute data, and it measures their PA with the number of MET-minutes the participant engaged in every minute. MET-mins is just the MET value of the activity times the number of minutes at that MET value (so x1 in this case). So 150 min/week \* 3 MET = 450 MET-mins per week is the recommendation. survey weights will be needed because there is a high and low minority track. There are some extreme outliers, so we limit our population to those have <2000 Y2. 1057 individuals then

33. To make the measurement error modeling easier, we define 2 random variables to model. we define a bout as CDC in NHANES does: 8 out of 10 minutes in at least MVPA, rolling window then must have 8 out of 10 minutes in MVPA always. If last 2 minutes are not in MVPA this doesn’t count. Y2 is the sum of MET-mins across all bouts for an individual in a day above the 10 minute minimum. Moderate exercise has a min MET value of 3, so 3\*10=30 MET-mins in the min number of MET-mins someone could accrue and count toward their total.

34. We will assume independence between individuals, but we need to see if there is a day effect, ie. Whether individuals systematically performed for exercise on trial 1 because they were being watched etc. We performed a paired t-test for mean of diff = 0 and had p-value of 0.24. We created a contingency table for all individuals and we want to know if this matrix is symmetric because that would be an overall indicator of no day effect and thus assuming exchangeability within individuals is okay. Here we plot only nbouts up to 10 because it becomes very sparse, we ran the test on this and a subset 1-6 because the test can be sensitive when there are lots of 0s, results were consistent.

35. Similarly, we would like to assume Y2 within individual are exchangeable. We also check for a weekend effect. To remove person effect we take differences and

36. Since we have count data with measurement error and likely overdispersion, this seemed like a good place to start. Fit this model in JAGS independtly of the second part of the model to assess fit. One of our concerns with this model is within person variability is var(y1|x1) = X1, which may not be flexible enough for the data. First, we assess the models for all individuals.

37.

38. The way we constructed Y2 is that it takes values 0 and positive. A 2-part model is typically for semicontinous data like this, where we allow some probability of observing a 0 and some probability of being >0, then conditional on >0, we model that data.