Fasting Time
in CDC NHANES

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In Summary …

Fasting time can affect results of NHANES (and other epi) studies, *however, these effects seem less than one might expect.*

This reduced effect of fasting time (i.e., reduced relationship with experimental PK) could be caused by: 1) changes in absorption due to mixing with food, 2) "kinetic buffering" by body fat (mesenteric ?) during chronic exposure, 3) imprecision of fasting time as measure of time since exposure, 4) non-food routes of exposure, 5) inaccuracy of self-reported fasting.

I do not know any way to conclusively validate self-reported fasting times in NHANES or other epi studies, *however, my attempts to validate through use of other internal data suggests that most (not all !) fasting times are likely correct, or correct enough*.

Adjusting for fasting time may give increased precision in some epi studies of rapidly-cleared, food-borne environmental toxicants, *however, fasting time is linked to other covariates, and so (as always), one must think, and not simply adjust.*

Why do we care about Fasting Time ?

Affects on exposure measurement

- Food-based exposures with rapid clearance

Affects on outcome measurement

- Glucose, insulin, triglycerides, LDL, etc.

What is "Fasting Time" (FT) in NHANES ?

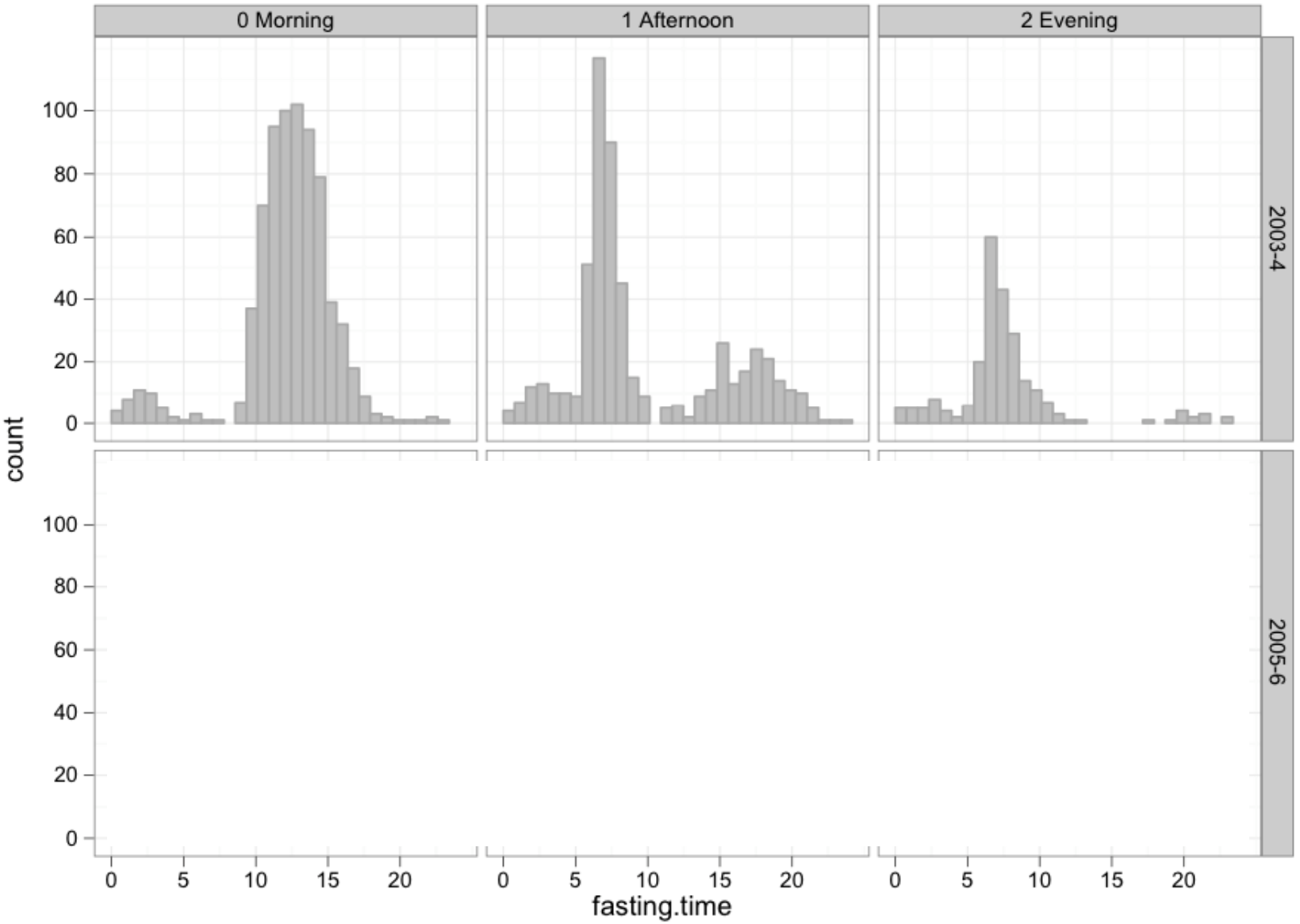
FT = hours/minutes since last food or drink "other than plain water".

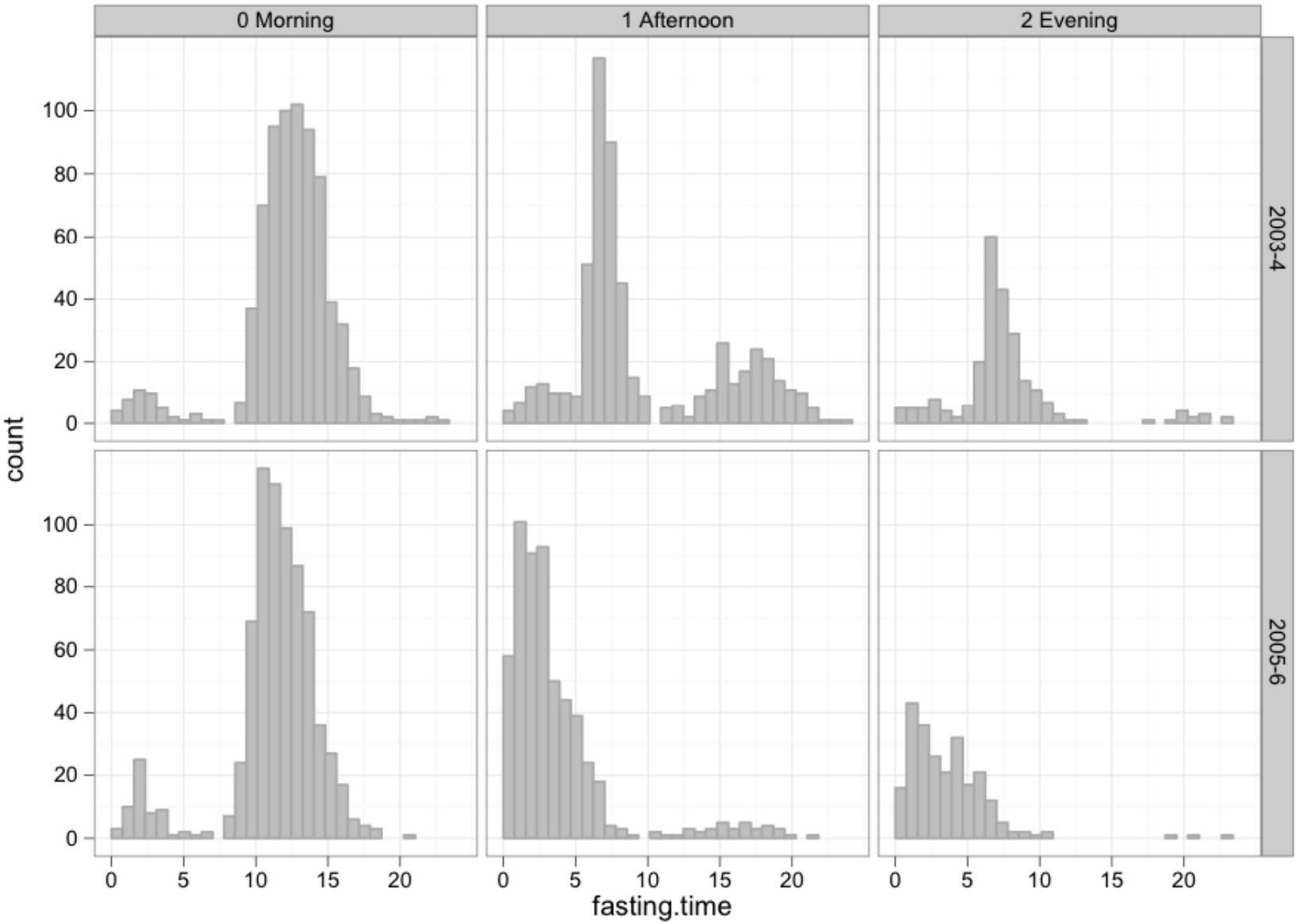
- Does *not* consider diet drinks, alcohol, and minor items, because, presumably, the purpose of FT in NHANES is to enable valid "fasting" blood tests (fasting glucose, insulin, triglycerides, LDL).

Other details:

- Everyone has a "fasting time", but …
- "Fasting" is only considered valid if FT is between 8 and 24 hours. In 2003-4 is only from the morning session subjects, ages ≥ 12 yrs, etc..
- Fasting data is invalidated by zeroing out subsample WEIGHTS, not the data itself. For our purposes, this is good.

WARNING: these details can CHANGE


0 Morning
1 Afternoon
2 Evening
2003-4
2005-6
count
fasting.time
0
20
40
60
80
100
0
5
10
15
20


0 Morning
1 Afternoon
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count
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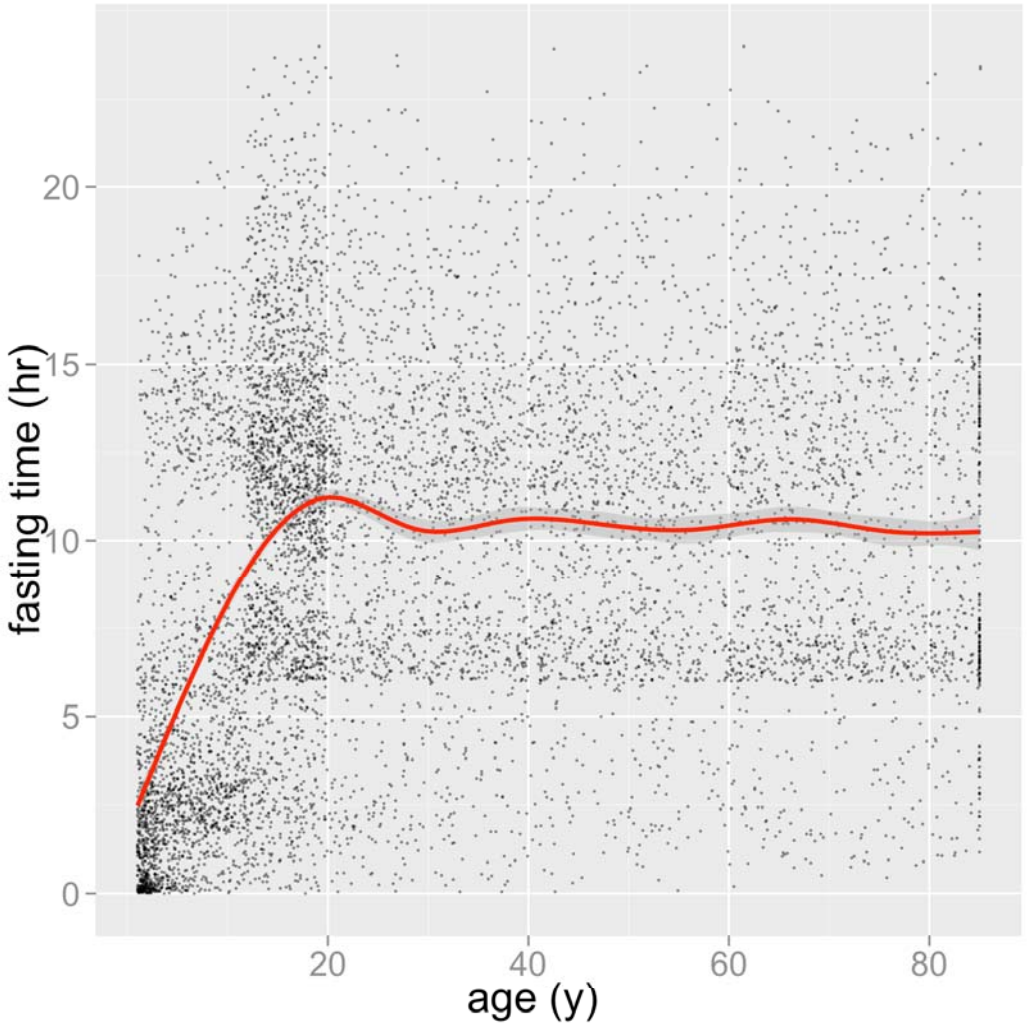
40
60
80
100
0
5
10
15
20

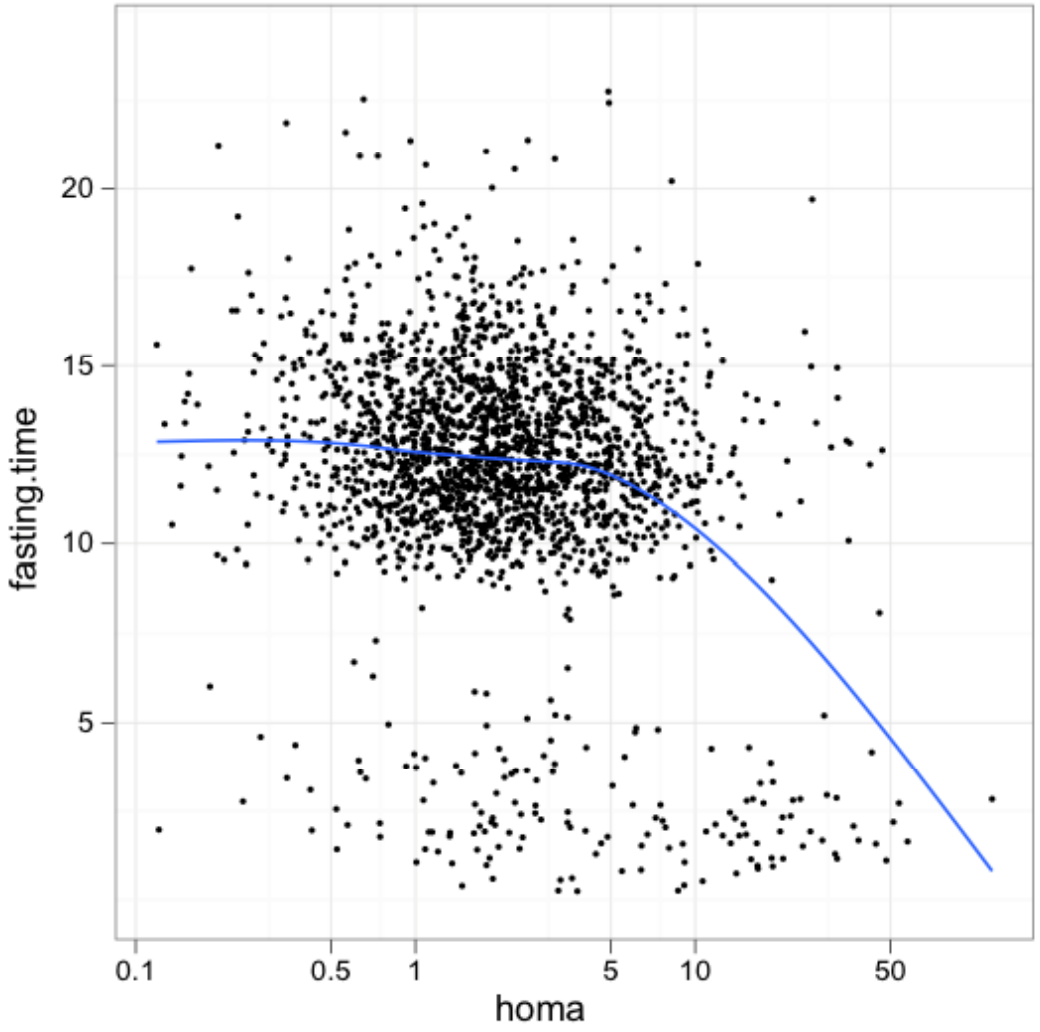
Factors affecting FT

- Session (morning, afternoon, evening)
- **Age**
- Insulin status (2003-4)



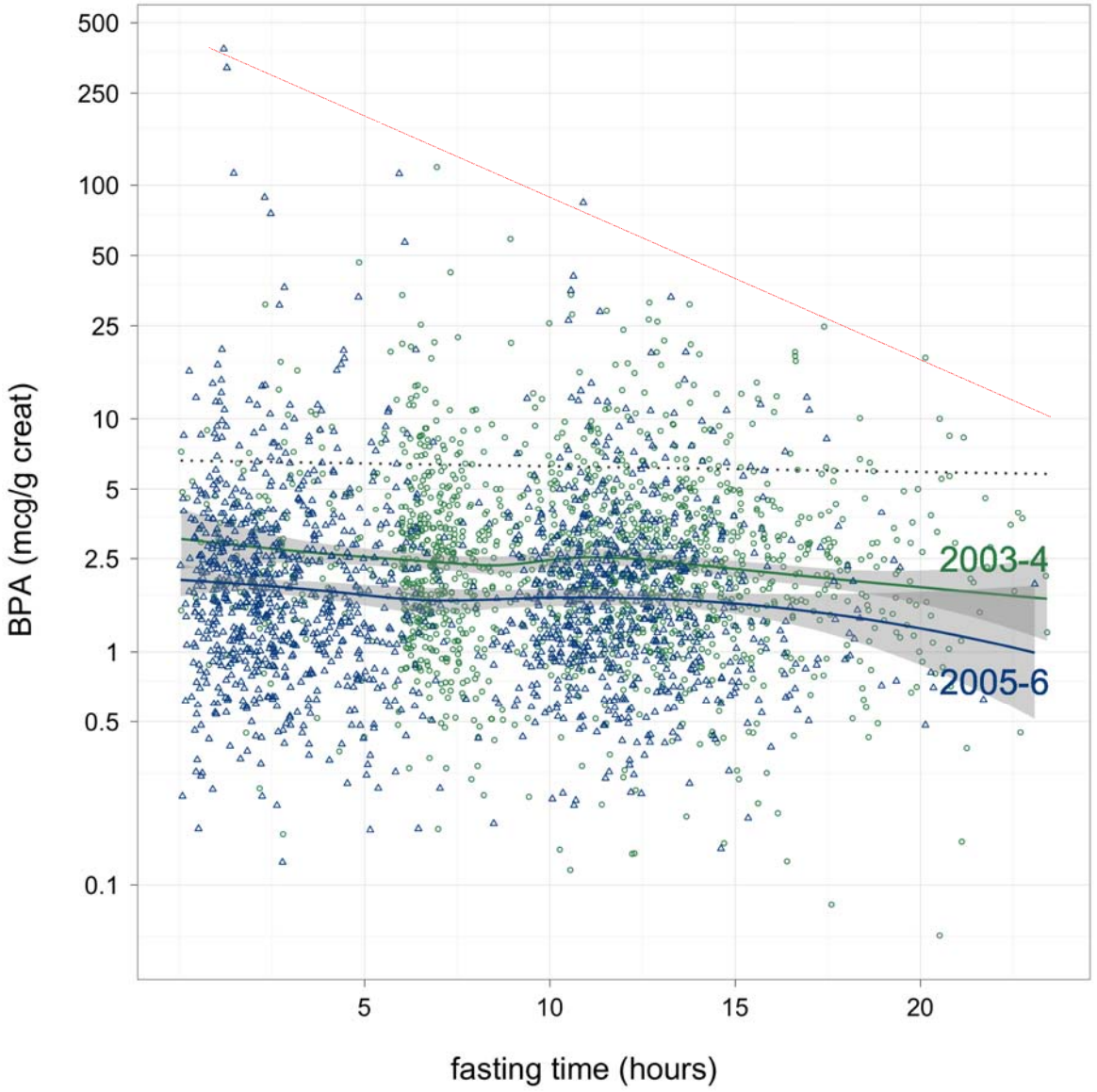
Factors affecting FT

- Session (morning, afternoon, evening)
- Age
- **Insulin status (2003-4)**

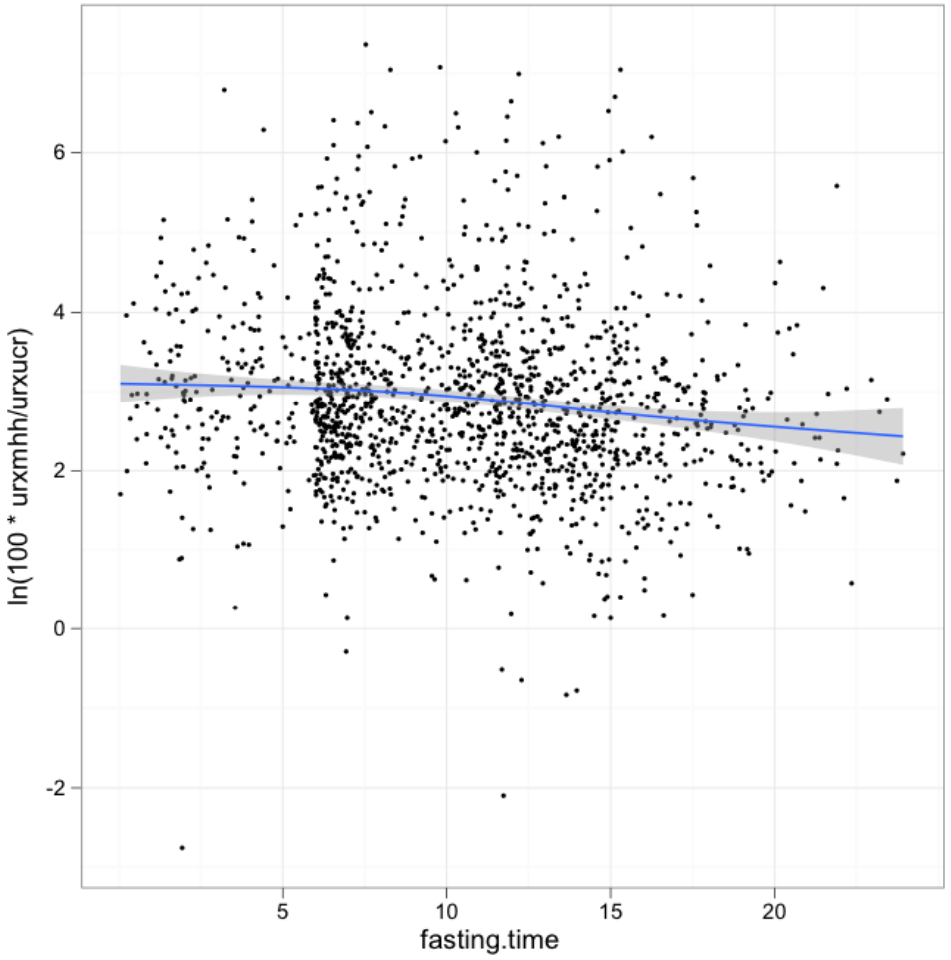


FT affecting …

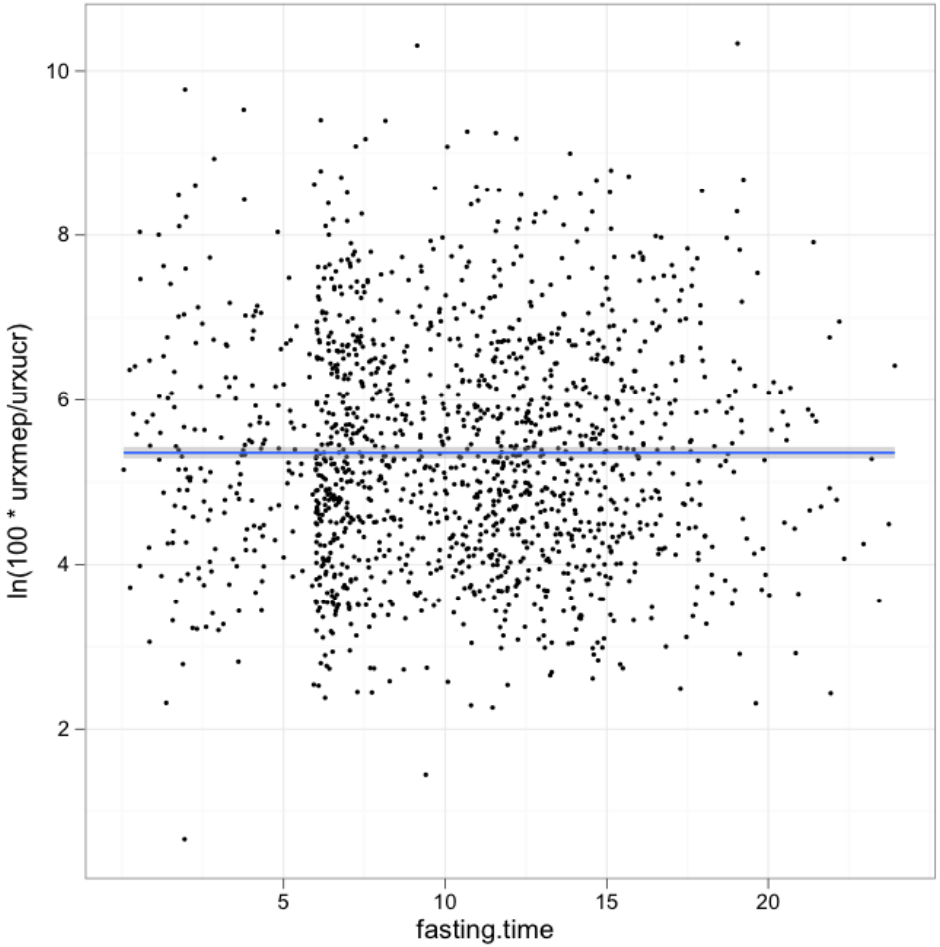
BPA



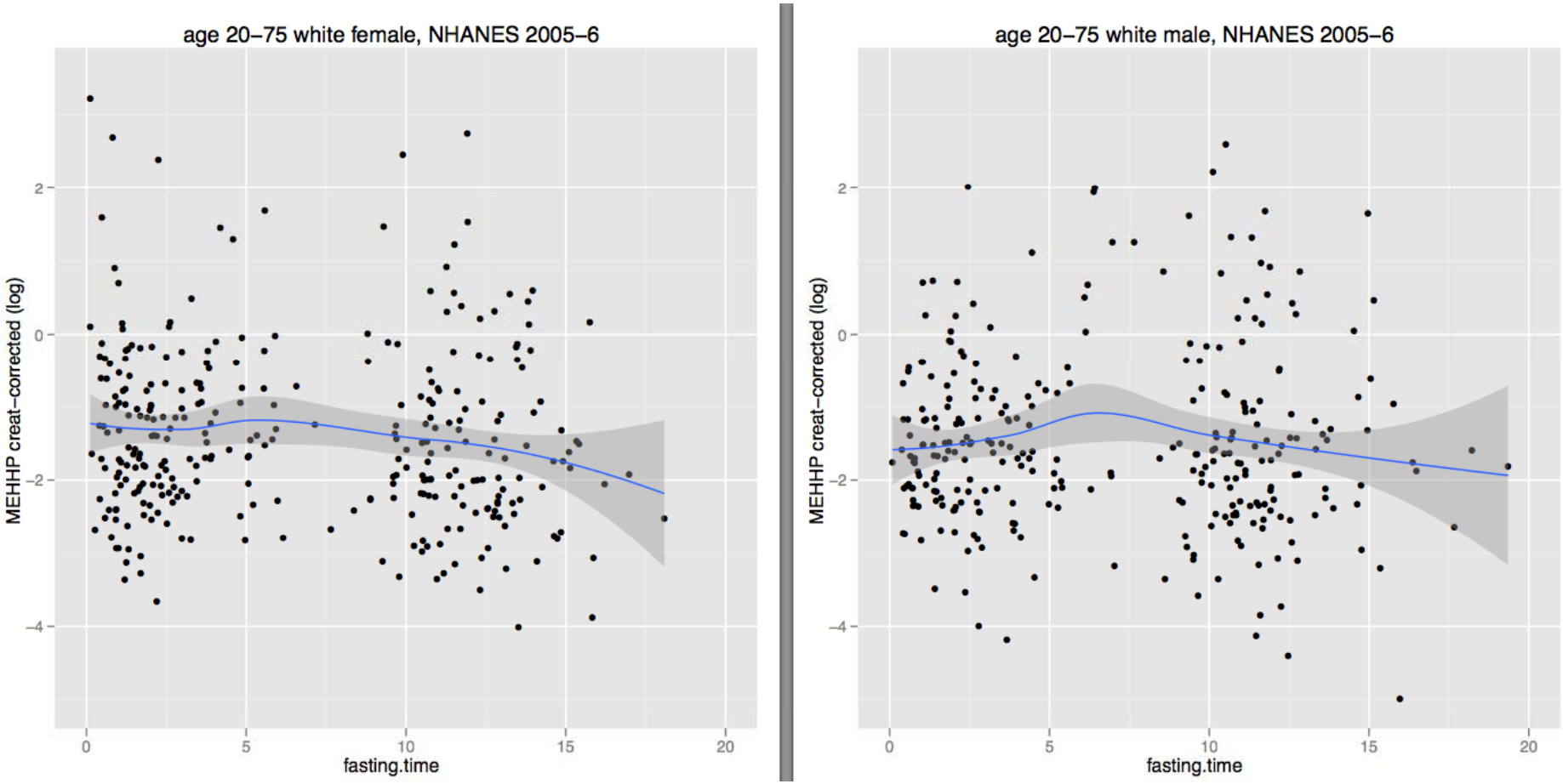
MEHHP (ln, creat-corrected)



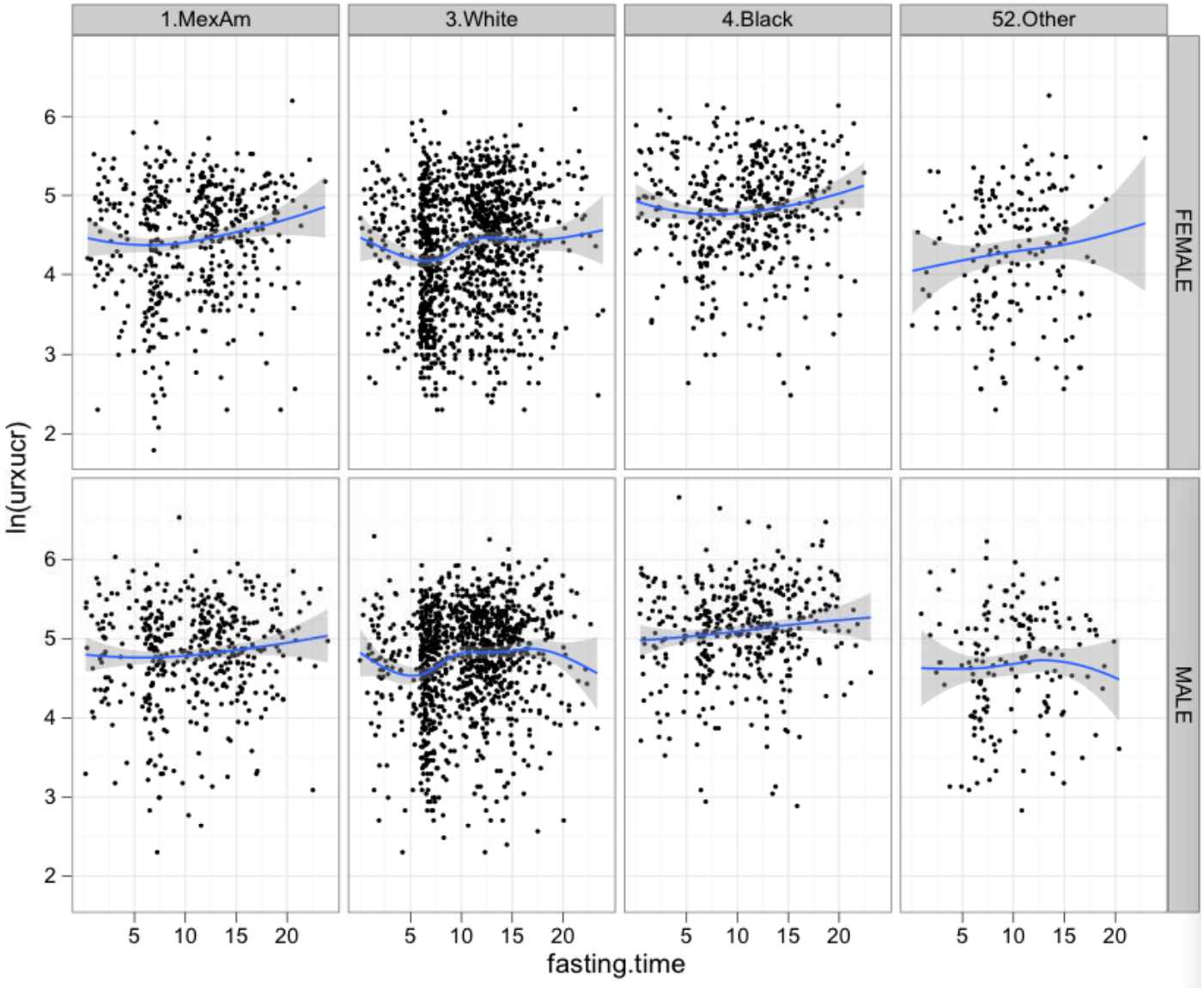
MEP (ln, creat-corrected)



MEHHP (more specific urine creat subset, 2005-6)



Urine Creatinine (ln)



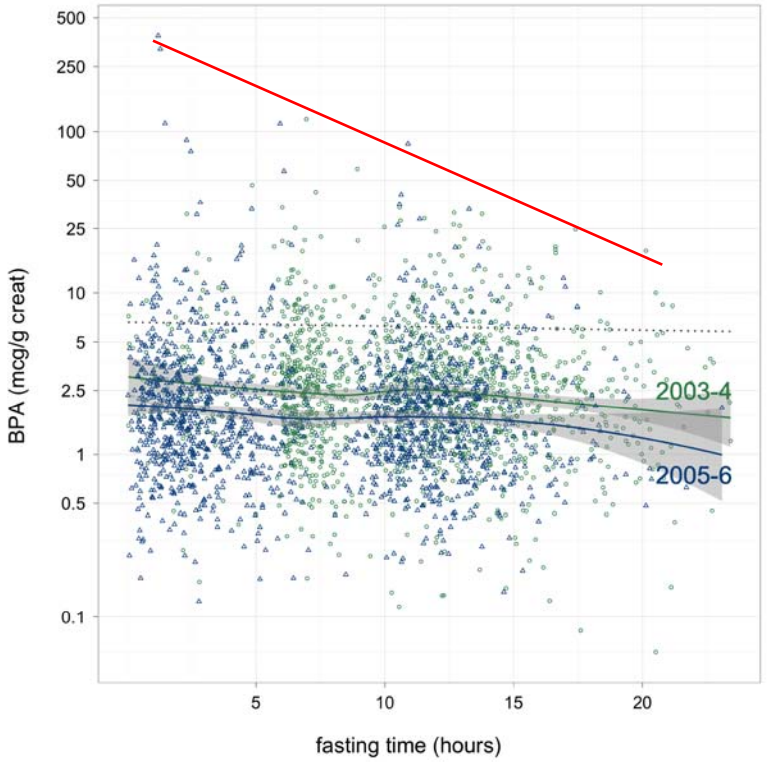
Increasing concentration (+/- mild catabolism ?)

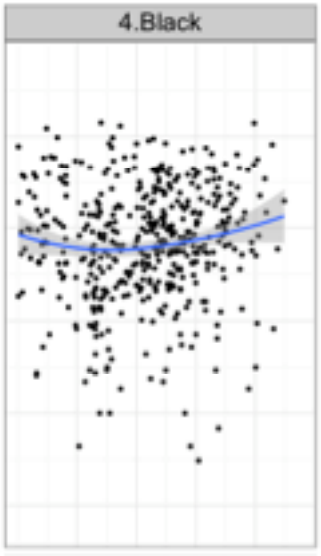
Yes, but can we trust self-reported Fasting Times ???

Especially given:

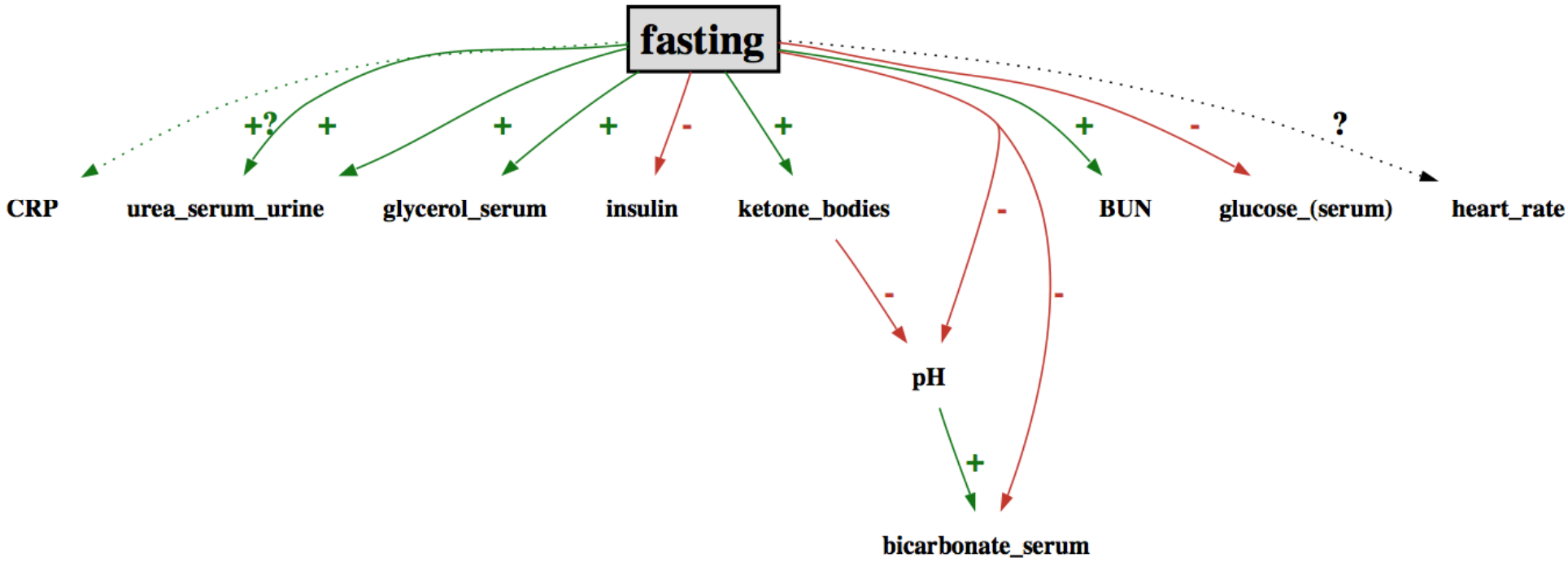
- Unexpected BPA and MEHHP results ?
- Additional payment (+~$30) if properly fasting ?

Validation attempts/clues …



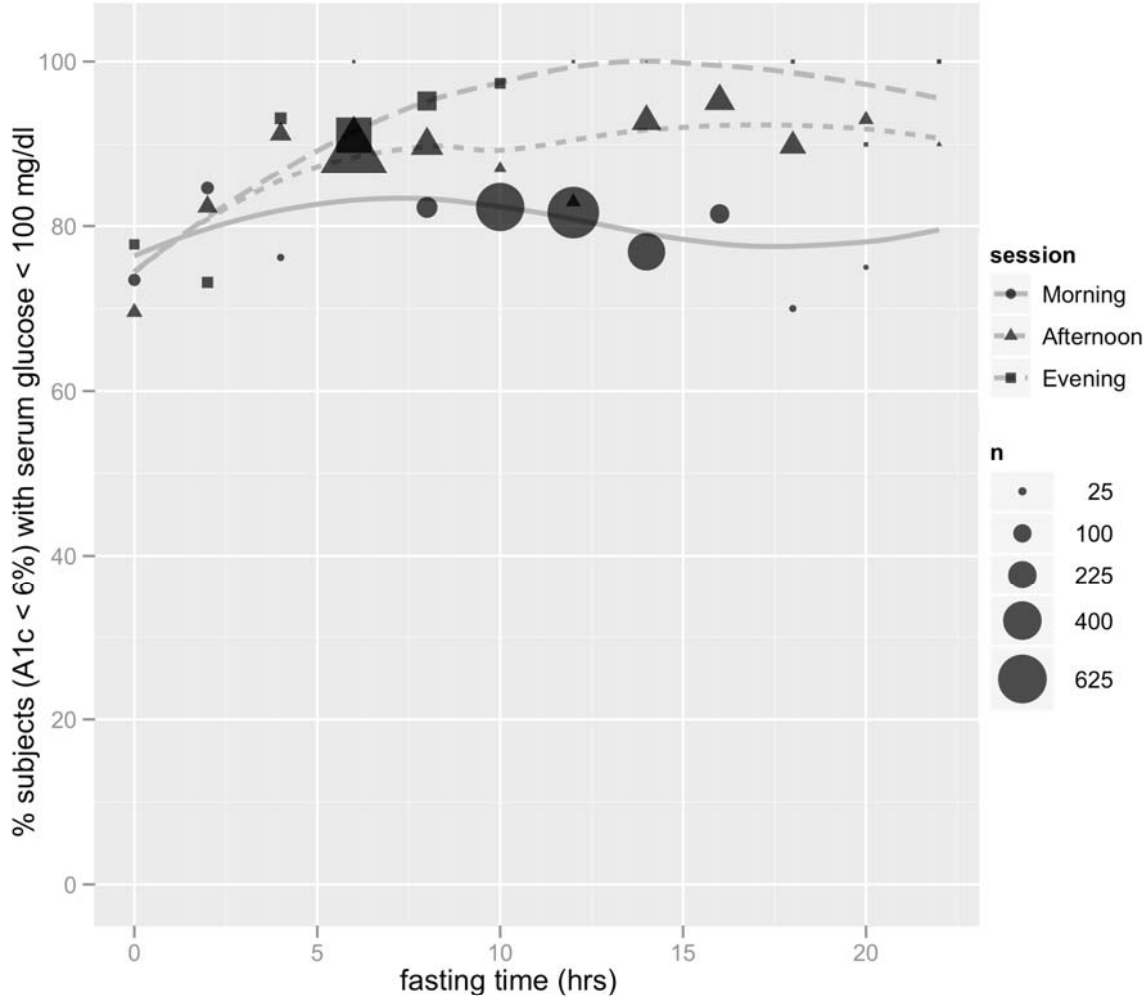


More ideas …

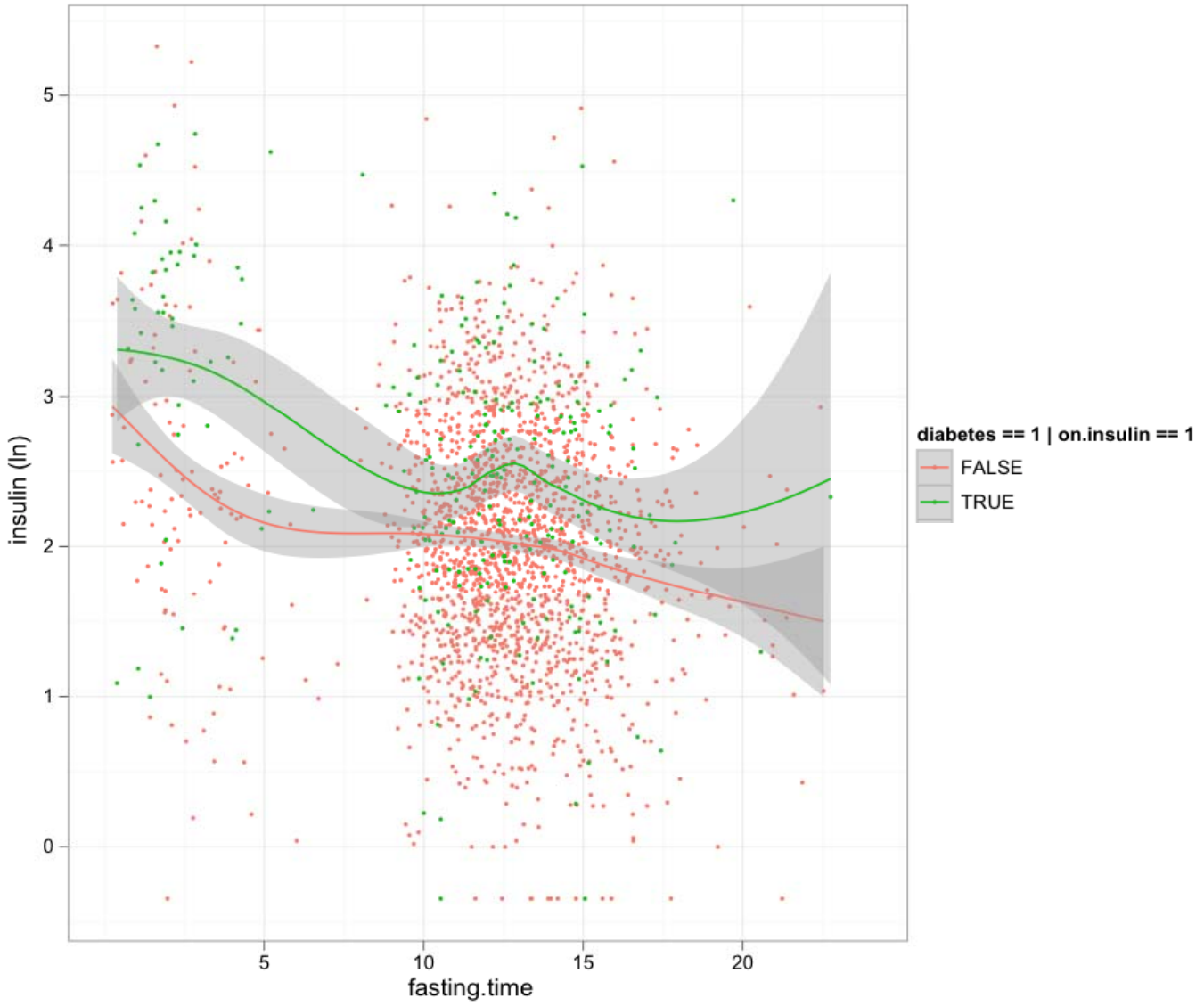


% of normoglycemic subjects with "good" serum glucose

(i.e., did not eat recently, maybe)

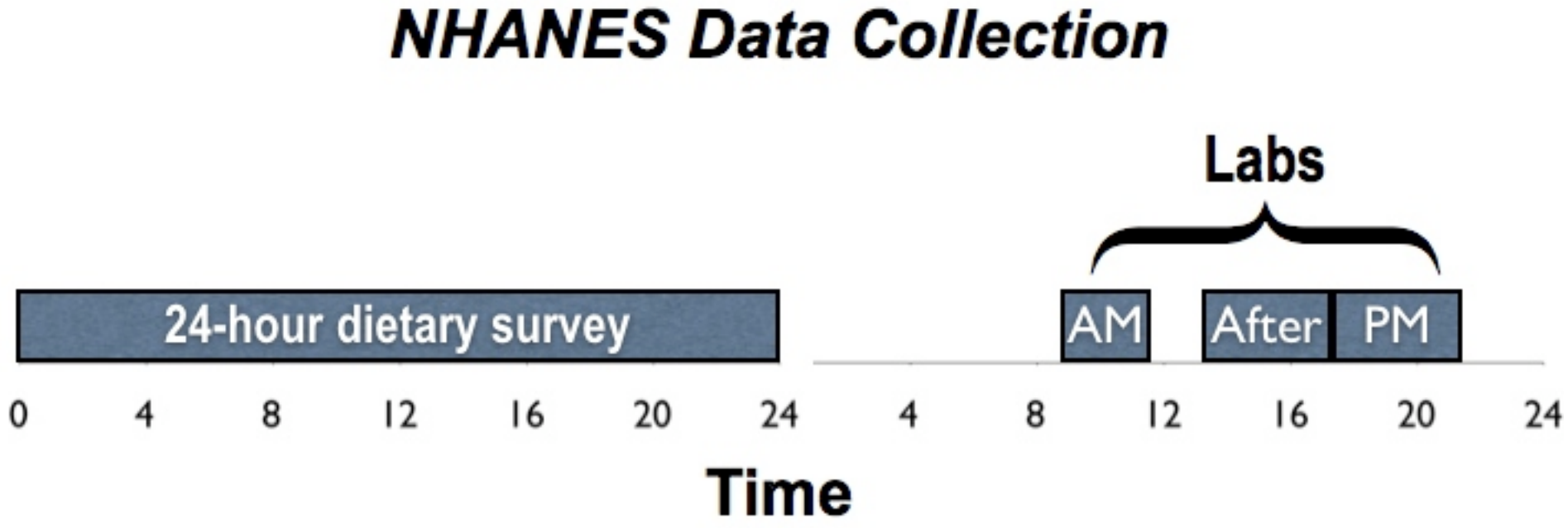


Insulin (ln) – (diabetes = 1 OR on.insulin = 1) or NOT



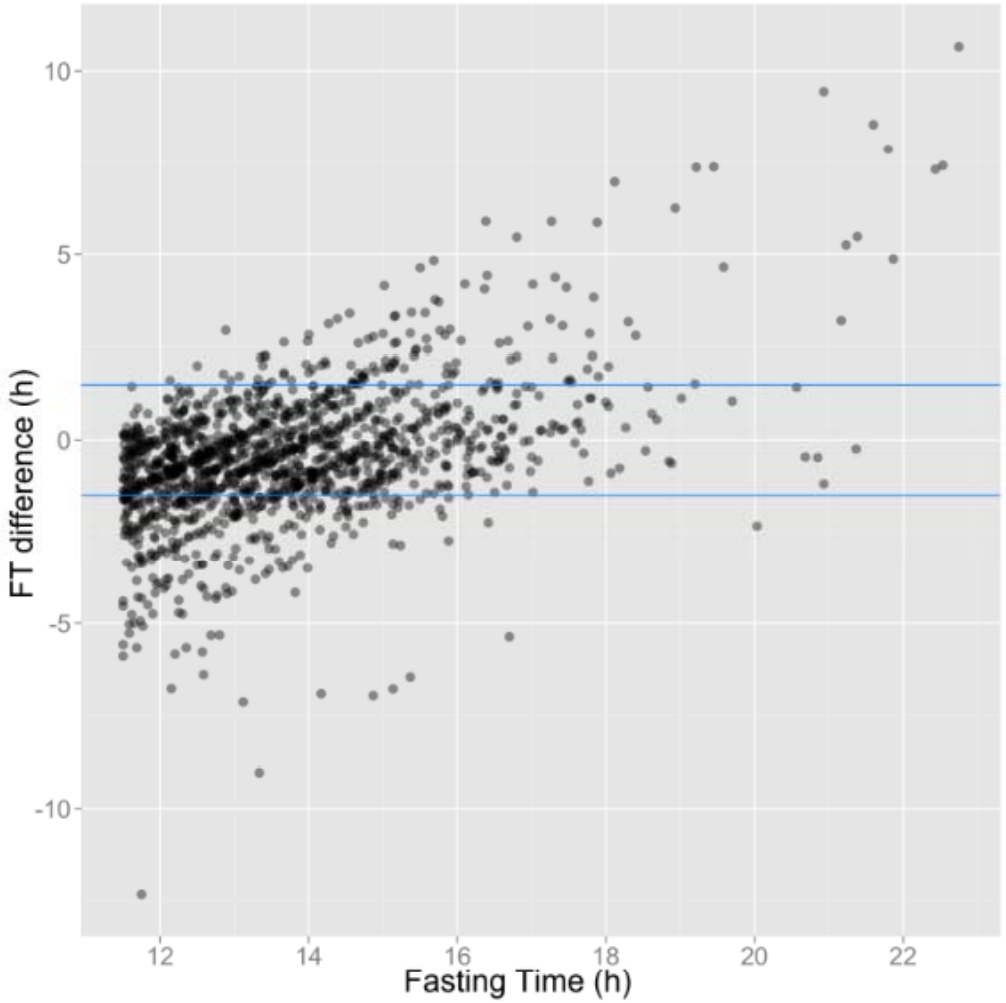
Stronger validation ?

Use dietary survey to cross-check



Difference between self-reported FT and the FT calculated from dietary history. This difference, plotted vs. self-reported FT

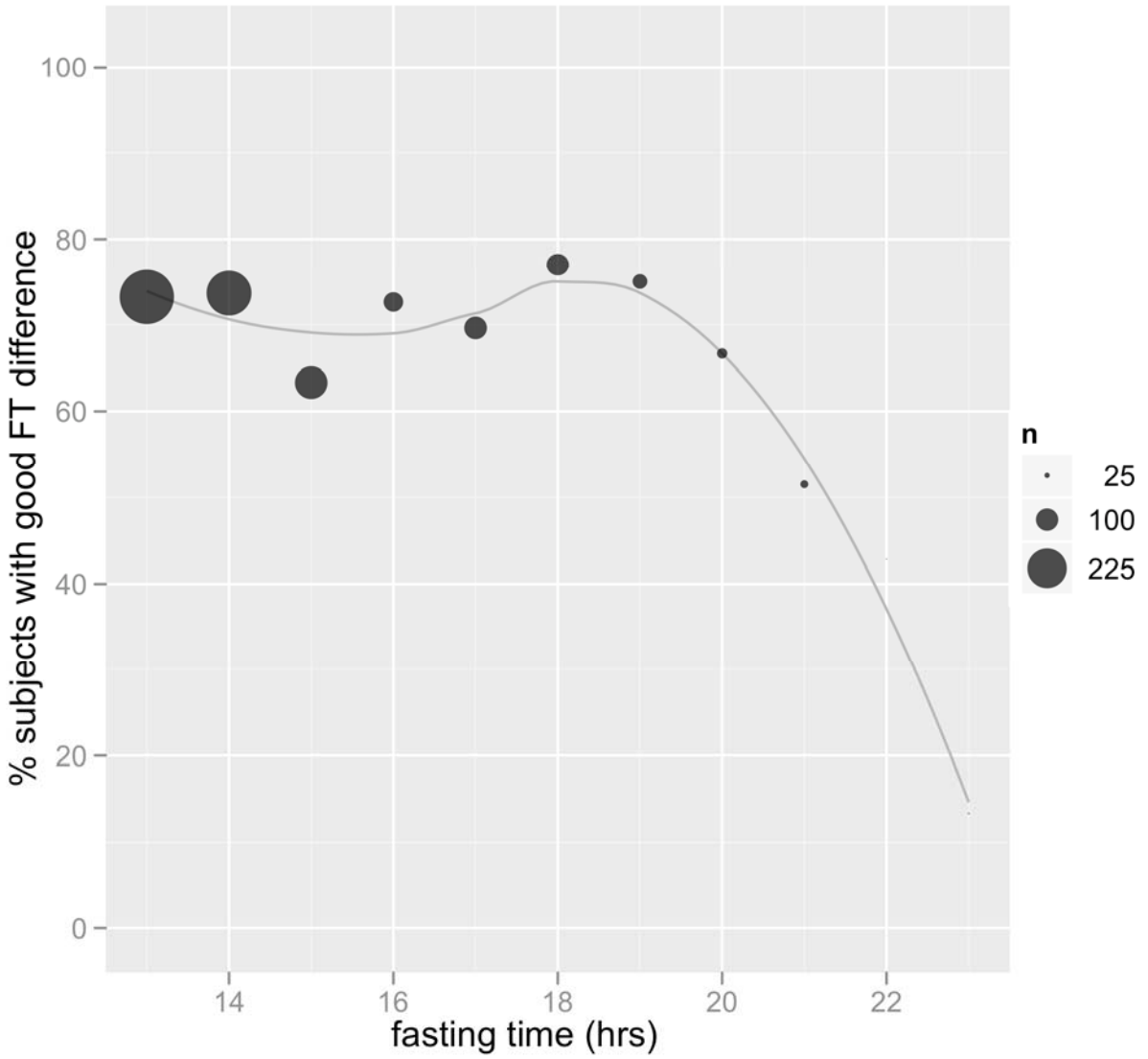
Morning session only; age >= 20. N = 2209.



Reported FT > FT calculated from dietary history

"Match" (± 1.5 h)

Reported FT < FT calculated from dietary history


% subjects with good FT difference
100
80
60
40
20
0
14
16
18
20
22
fasting time (hrs)
n
25
100
225

HOMA (ln) = MEHHP (ln) + covars

```
> model=lm(homa.ln ~ mhh.ln  + urxucr  + creat.sqrt + age +  race.c ,
data=explore2); summary(model)

Call:
lm(formula = homa.ln ~ mhh.ln + urxucr + creat.sqrt + age + race.c,
    data = explore2)

Residuals:
     Min       1Q   Median       3Q      Max
-2.59359 -0.57156 -0.01131  0.56874  3.00876

Coefficients:
               Estimate Std. Error t value Pr(>|t|)
(Intercept)    0.499893   0.496272   1.007 0.314547
mhh.ln         0.160929   0.043442   3.704 0.000249 ***
urxucr         0.000645   0.002530   0.255 0.798932
creat.sqrt    -0.051264   0.070442  -0.728 0.467292
age            0.005680   0.002996   1.896 0.058864 .
race.c3.White -0.040685   0.136460  -0.298 0.765783
race.c4.Black -0.075400   0.172767  -0.436 0.662818
race.c52.Other -0.016826   0.241691  -0.070 0.944542
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9707 on 323 degrees of freedom
  (390 observations deleted due to missingness)
Multiple R-squared: 0.05256,    Adjusted R-squared: 0.03203
F-statistic:  2.56 on 7 and 323 DF,  p-value: 0.01405
```

Same + *fasting.time*

```
> model=lm(homa.ln ~ mhh.ln + fasting.time + urxucr  + creat.sqrt + age +
race.c , data=explore2); summary(model)

Call:
lm(formula = homa.ln ~ mhh.ln + fasting.time + urxucr + creat.sqrt +
    age + race.c, data = explore2)

Residuals:
     Min       1Q   Median       3Q      Max
-2.60856 -0.55313 -0.01444  0.61563  2.67821

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)    1.158e+00  4.953e-01   2.337  0.02006 *
mhh.ln         1.273e-01  4.238e-02   3.003  0.00288 **
fasting.time  -7.240e-02  1.423e-02  -5.088 6.15e-07 ***
urxucr        -2.593e-05  2.441e-03  -0.011  0.99153
creat.sqrt    -2.308e-02  6.810e-02  -0.339  0.73491
age            7.120e-03  2.901e-03   2.454  0.01464 *
race.c3.White -1.223e-02  1.316e-01  -0.093  0.92600
race.c4.Black -8.640e-02  1.665e-01  -0.519  0.60413
race.c52.Other -2.890e-02  2.329e-01  -0.124  0.90134
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9353 on 322 degrees of freedom
  (390 observations deleted due to missingness)
Multiple R-squared: 0.1231, Adjusted R-squared: 0.1013
F-statistic: 5.649 on 8 and 322 DF,  p-value: 1.010e-06
```

In Summary …

Fasting time can affect results of NHANES (and other epi) studies, *however, these effects seem less than one might expect.*

This reduced effect of fasting time (i.e., reduced relationship with experimental PK) could be caused by: 1) changes in absorption due to mixing with food, 2) "kinetic buffering" by body fat (mesenteric ?) during chronic exposure, 3) imprecision of fasting time as measure of time since exposure, 4) non-food routes of exposure, 5) inaccuracy of self-reported fasting.

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