If My Blood Pressure Is High, Do I Take It To Heart?

Behavioral Impacts of Biomarker Collection in the Health and Retirement Study

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Motivation

- In 2002, when I was 30 years old, my doctor in San Francisco told me my blood triglycerides were high

- He said I needed to lose 20 pounds

- My girlfriend (later my wife) went on a trip, I ate vegetables, and some time later I saw my doctor and had lost 20 pounds

- My doctor said, "I don't believe it! Nobody ever actually does what I say!"

Motivation

- In 2013, when I was 40 years old, I had my blood work done in New York City

- The results were made available to me online

LIPID PANEL

Test	Result	Flag	Normal Range
CHOLESTEROL,TOTAL	228 mg/dL	High	125-200
HDL CHOLESTEROL	58 mg/dL		>=40
CHOLESTEROL/HDL RATIO	3.9		< = 5.0
LDL CHOL, CALCULATED	146 mg/dL	High	<130
Desirable range <100 mg/dL for patients with CHD or diabetes and <70 mg/dL for diabetic patients with known heart disease.			
TRIGLYCERIDES	118 mg/dL		<150
NON HDL CHOLESTEROL	170 mg/dL	High	
Target for non-HDL cholesterol is 30 mg/dL higher than LDL cholesterol target.			

Motivation

- My doctor emailed me

- Dear Mr. Edwards,

  Dr. P___ has reviewed the results of your latest lab work. Your cholesterol levels are high. Dr. P___ recommends diet changes, exercise, and weight loss. Please visit health.org for valuable information on leading a heart healthy lifestyle.

  Best,
  D___ P___ C___

- Ironically, I had already started a weight loss regimen that had replaced carbohydrates with foods probably too high in cholesterol

- And then I traveled to Paris

Outline of talk

1. What are biomarkers & why are they interesting in social science research?

2. Informed consent, collection of biomarkers, & notification

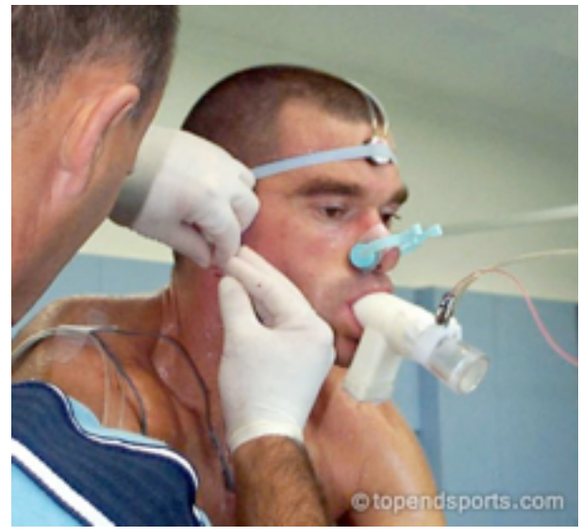
3. Overview of biomarker collection & notification in the Health and Retirement Study

4. Measurement & statistical issues

5. Results

6. Next steps

Biomarkers



- Objective measures of biological characteristics, often just stuff your doctor wants from you all the time

- Examples range from simple to complex: height/weight, strength/balance/breath, blood pressure/composition, to genes and DNA

- Pretty old-hat in biomedical survey and clinical studies, but relatively new in social science & demographic surveys

- Examples of high-impact findings:
  - Danish twin studies show 25% of variation in longevity is genetic
  - Whitehall II: Work stress, metabolic syndrome, heart disease

Biomarker collection may also reveal information to respondents

- Informed consent typically requires disclosure of known risks associated with the survey, trial, or experiment

- With biomarker collection, Institutional Review Boards (IRBs) may require that survey respondents be notified of risky levels

  - Notably, not with Demographic and Health Surveys' (DHS) anonymized HIV/AIDS screening in developing countries!

  - With the U.S. Health and Retirement Study (HRS), the PI's felt they should notify participants of up to 4 abnormal biomarker readings

  - Other surveys with biomarkers? Add Health notifies about STI's

The Health and Retirement Study

- A biennial panel survey begun in 1992 and expanded in 1998 to become representative of ages 50+ with new cohorts added often

- Included 18,469 respondents in its eighth wave in 2006

- Has a very rich cross-sectional structure and low panel attrition

- Has been primarily a telephone-based survey, with face-to-face interviews for respondents in nursing homes & in other circumstances

- Starting first with a small pilot in 2004 and then extensively in 2006, began collecting biomarkers on rotating halves of the sample

HRS biomarker collection

- Ostensibly for budgetary reasons, the HRS now collects biomarkers on one randomly selected rotating half of the sample each wave
  - Flip a coin
    - Heads: I biomark now and again in 4 years, again in 8 years
    - Tails: I biomark in 2 years, again in 6 years, and so on

- Collection occurs roughly in the middle of an Enhanced Face-to-Face interview, after the health assessments and before employment

- Subjects are sequentially asked their consent to three sets of measures:
  - Physical: grip, breath, balance, walking, blood pressure, height/weight
  - Saliva: swish Scope mouthwash and spit into a container
  - Blood: blood spot obtained via finger prick

HRS biomarker notification

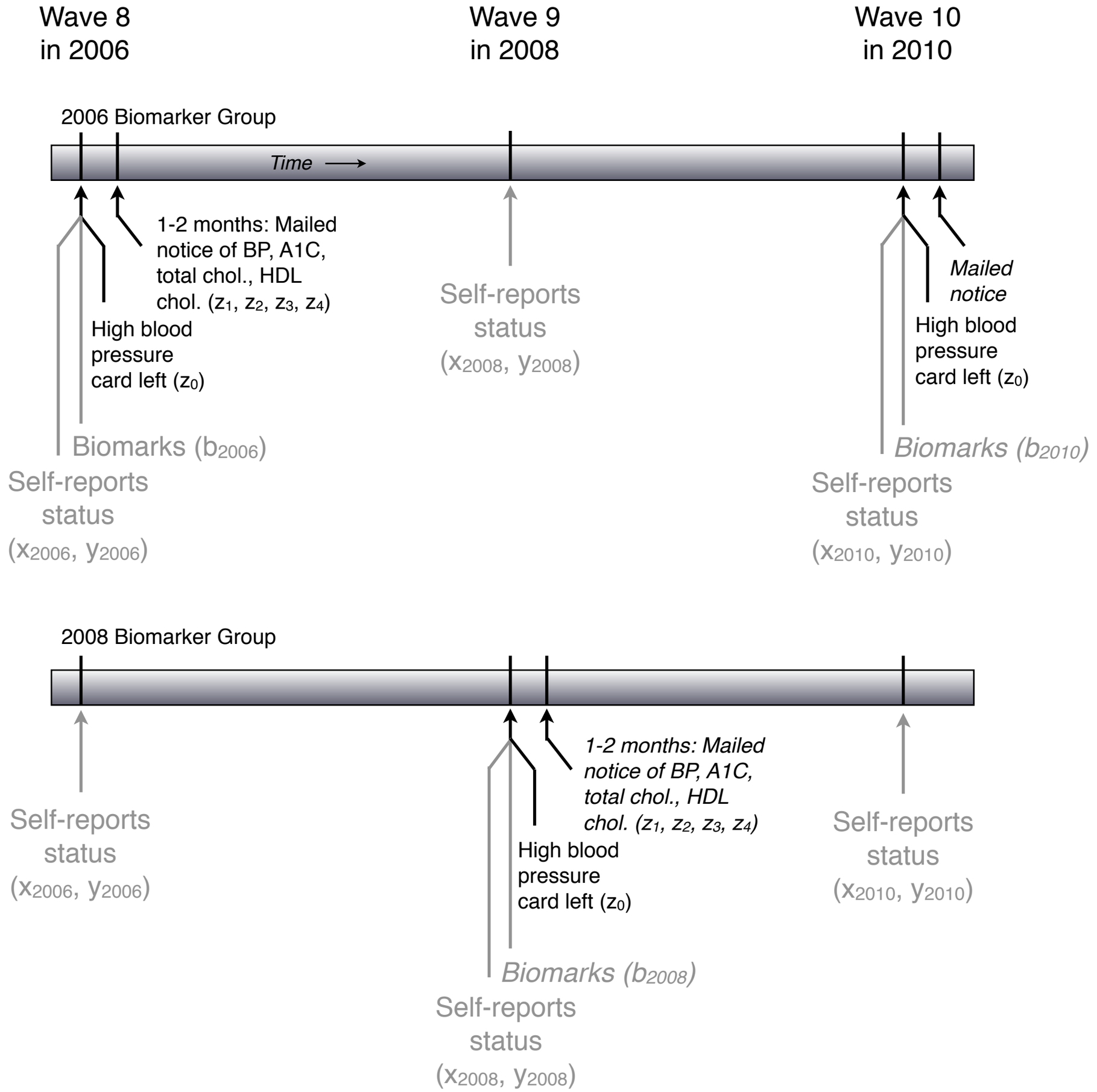
- HRS notified respondents about up to 4 abnormal biomarker readings:

1. Blood pressure *hypertension*
2. Blood hemoglobin A1C *diabetes*
3. Total cholesterol *heart problems*
4. HDL ("good") cholesterol *heart problems*

- HRS interviewers left behind a "high blood pressure card" if minimum BP > 160 systolic or > 110 diastolic — a potential "hypertensive crisis"

- Full BP and blood results were mailed out an average of 2 months later with all respondents receiving the same boilerplate guidance
  - Blood pressure: "high" if systolic > 120 or diastolic > 80
  - Blood hemoglobin A1C: "high" if ≥ 7.0 (some recommend ≥ 6.5)
  - Total cholesterol: "high" if ≥ 200 (NHLBI recommends ≥ 240)
  - HDL cholesterol: "low" if < 40
- If the lab could not analyze blood results, a separate notification was sent

Key events in the HRS data collection timeline by biomarker group



Measurements in gray

Notifications in black

Unreleased data in italics

HRS biomarker notification letters left respondents to "connect the dots"

HRS

John Q. Respondent
100 Main Street
Some Town, XY 12345

DATE OF TEST: June N[th], 2006

Dear HRS respondent,

Thank you for participating in the Health and Retirement Study. Our lab has completed the processing of your blood spot sample. On the enclosed page you will find your results. As you know, we cannot provide any medical advice to you. If you have questions about these results, please contact your doctor.

We look forward to your continued interest and participation in all aspects of this nationally recognized and highly respected study. If you have questions about this study, please contact us at 1-800-XXX-XXXX.

Sincerely,

David Weir,
Director – HRS

1

Blood Pressure Readings:

	systolic		diastolic	
Time 1:	131	/	80	mmHg
Time 2:	129	/	79	mmHg
Time 3:	128	/	78	mmHg

According to the American Heart Association, systolic pressure of 120 mmHg or higher, and a diastolic pressure (bottom number) of 80 mmHg or higher may indicate hypertension (high blood pressure). The Health and Retirement Study may not measure blood pressure in the same way that your blood pressure is measured in your doctor's office. However, if your blood pressure is 120/80 mmHg or higher, you should see your physician or other health professional to recheck this result and discuss it with them.

Total Blood Cholesterol: 190 mg/dL

According to the American Heart Association, total cholesterol of 200 mg/dl or higher may indicate hypercholesterolemia (high cholesterol). If your total cholesterol is 200 mg/dL or higher you should see your physician or other health professional to recheck this result and discuss it with them.

HDL Blood Cholesterol: 55 mg/dL

According to the American Heart Association, high-density lipoprotein (HDL) cholesterol level of greater than 40 mg/dl helps to reduce the risk of heart disease. If your HDL cholesterol is lower than 40 mg/dL you should see your physician or other health professional to recheck this result and discuss it with them.

Hemoglobin A1C: 5.6%

The hemoglobin A1c test shows the average amount of sugar in your blood over the last three months. The American Diabetes Association recommends that the goal of this result should be less than 7%. If your result is 7% or higher you should see your physician or other health professional to recheck this result and discuss it with them.

2

The important text appears in red here, but not in the actual notification letters

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Hemoglobin A1C: 5.6%

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Out of 5 out-of-normal range notifications in the 2006 wave:

Three "rare and deadly," two "common and mundane"

All respondents assigned to 2006 biomarking	Submitted biomarkers	Received High BP card (160/110)	Had high BP (120/80), but no card	Had high A1c (≥7.0)	Had high total cholesterol (≥200)	Had low HDL cholesterol (<40)
8,587	7,127	412	3,809	387	2,399	383
	100%	5.8%	53.4%	5.4%	33.7%	5.4%

of whom:

105	1,459	47	2,013	257
1.5%	20.5%	0.7%	28.2%	3.6%

did not report already having a doctor's diagnosis of:

High BP	High BP	Diabetes	Heart problems	Heart problems

Basic research question:
Did collection & notification change anything?

- Reasons why:
  - People didn't know what their biomarkers were
  - People thought they knew & thought they were managing their biomarkers, but they were wrong

- Reasons why not:
  - People don't read or understand the notification
  - Americans aged 50+ are generally well insured & report high usage of care
    - People already knew their biomarker levels & were not surprised
    - People would have found out anyway by the next wave 2 years later
  - People do not care what their biomarker levels are
  - Measurement error in the biomarkers (Type-1 false positives)

- How do we specify treatment and control groups to find out?

What's the treatment?

- The salience of the notification — whether it's "really a treatment" — depends on the biomarker level. If it's within normal range, not salient(?)

- I can think of two useful definitions that are nested:

1. "Biomarker-Treated" = asked to submit biomarkers

    - The policy was unconditional biomarker collection, and we might want to know its average treatment effect (ATE) on the population aged 50+

2. "Notified-Treated" = submitting biomarkers and receiving a notification of a screen outside normal range

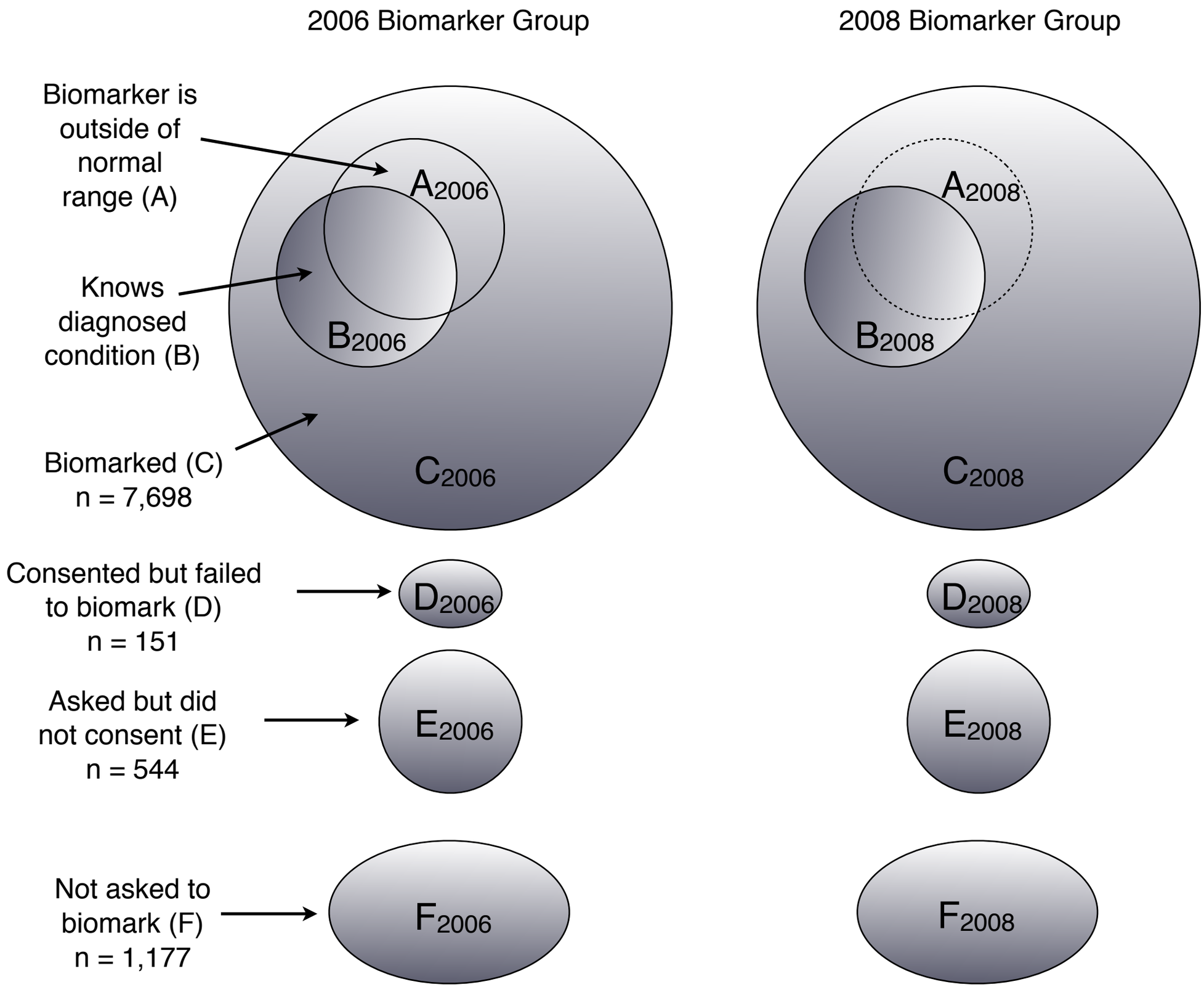
    - These participants seem most likely to respond; but if they are few in number, the ATE could be small even when the average treatment effect on these treated (ATET) is large

- Estimating ATE and ATET require somewhat different strategies

For estimating ATET, there is no natural control group that shares the characteristics of the notified-treated

- Their ideal control group: respondents who submitted biomarkers and would have been notified but were not
- But everybody who submitted biomarkers was also notified
- So what can we do?
  - The panel nature of the HRS allows panel fixed-effects estimation, which allows us to use past observations of the treated as controls
  - Basic difference in differences could also be informative & seem so
  - The randomized halving of the panel produced a kind of control in the group assigned to 2008, but we don't know their biomarkers
  - We can apply propensity score matching to guess abnormal screens
- By contrast, we can estimate ATE using the strong identification of randomized assignment as an "instrument" (regressor)

Disposition of the HRS sample in 2006 reveals ideal & feasible comparisons



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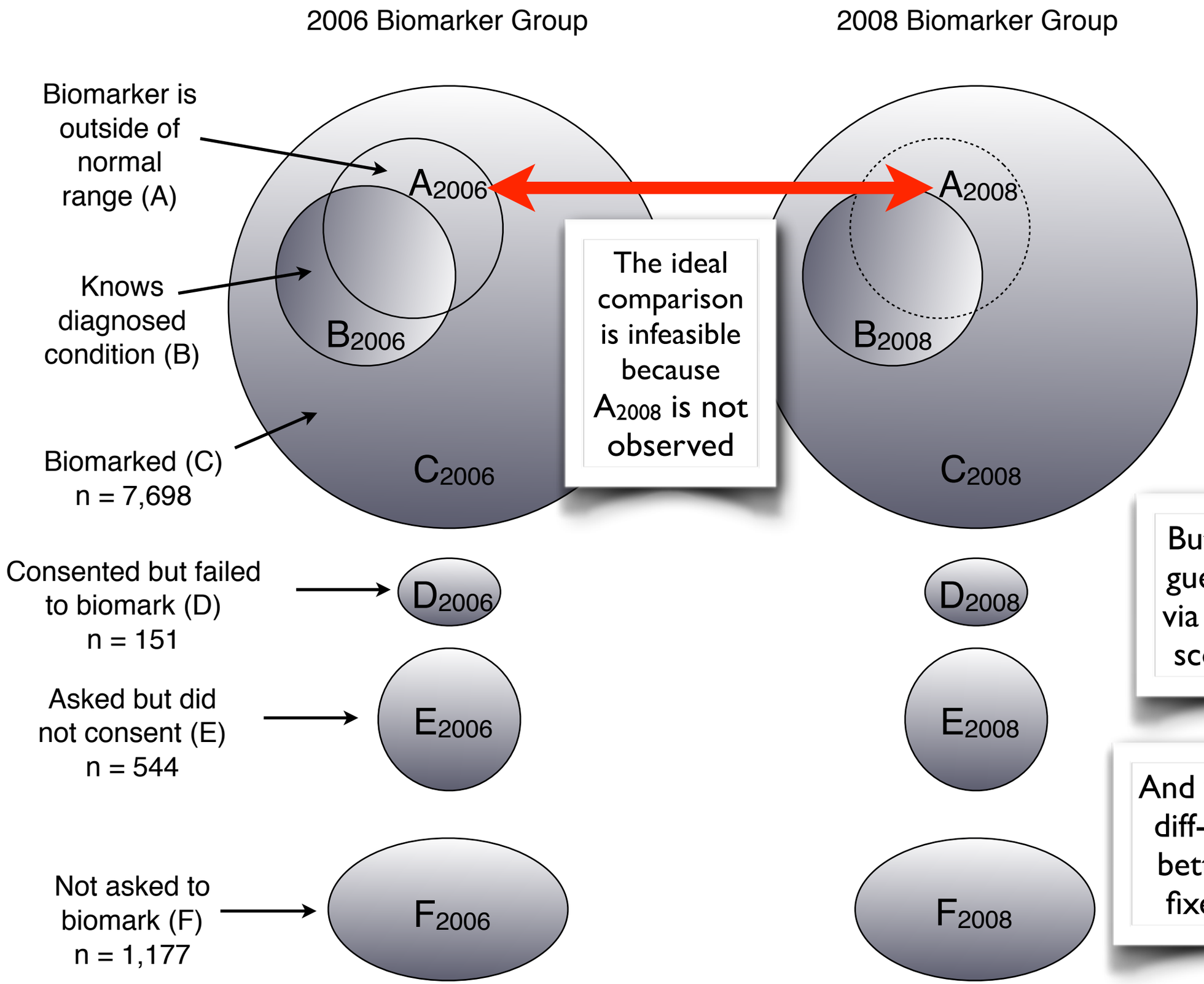
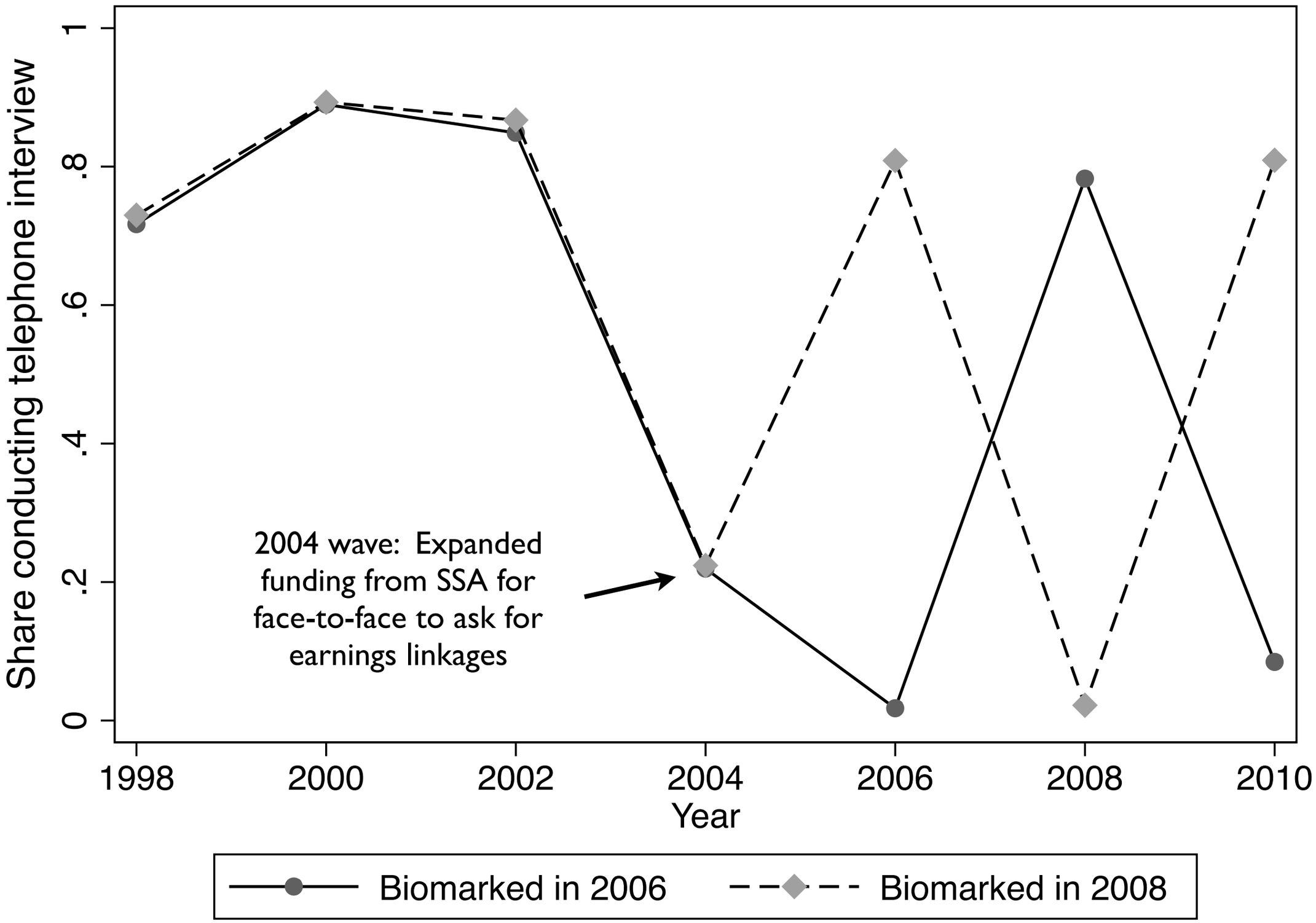
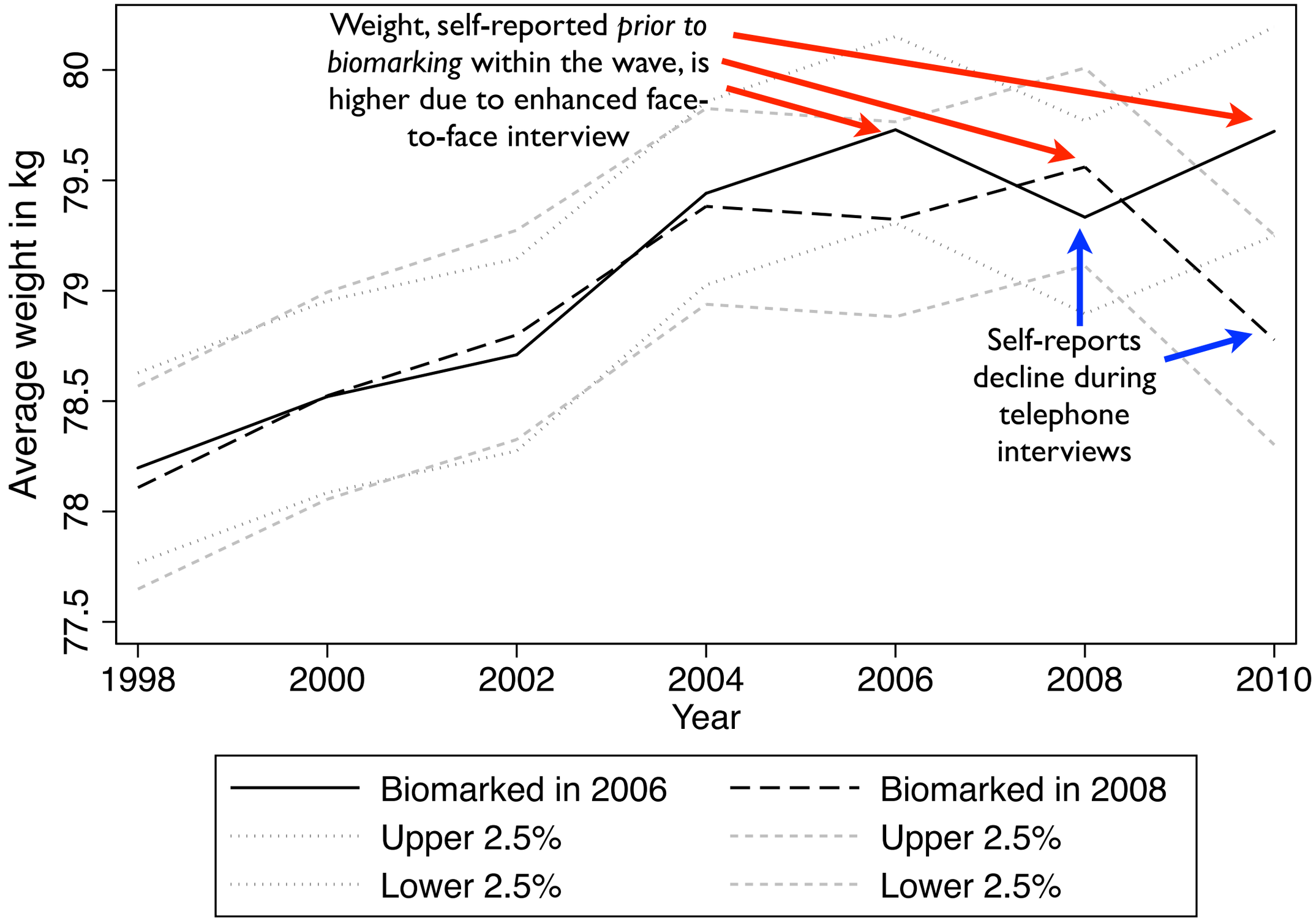


Measurement issues: Starting in 2006, polar differences emerge in mode of interview that are tightly correlated with biomarking



Mode of interview appears to affect some self-reports, like weight



Econometric setup

- For the ATE: Other things equal, I could compare average outcomes y_{it} for individual i at time t = 2008 between the 2006 and 2008 biomarker groups

- But because of mode-of-interview effects, I generalize to a panel setting:

$$y_{it} = \alpha_i + \beta^{ITT} b_{it-1}^{2006} + \gamma m_{it} + X_{it} B + \varepsilon_{it}$$

where b_{it-1}^{2006} is an indicator of assignment to the 2006 biomarker group, and β^{ITT} is the intent-to-treat estimate of its effect on y_{it}

- For the ATET: I want the reduced-form effect β_k of the k^{th} abnormal-biomarker notification for individual i at time t–1, z_{kit-1}, on y_{it}

$$y_{it} = \alpha_i + \Sigma \beta_k z_{kit-1} + \gamma m_{it} + X_{it} B + \varepsilon_{it}$$

- Advantages: I can interact the z_k with preexisting doctor's diagnoses to test how effects vary; and I can also test for reactions to *spouses' notifications*

- Other approaches:
  - Simple difference in differences (DID) within 2006 group; results are similar
  - Propensity-score matching; panel FE with matched/balanced sample are similar

Overview of results (1/4)

- For most outcomes, average treatment effects (ATE) of being asked to submit biomarkers are zero
  - "Rare and deadly" conditions are just that, with prevalence smaller than the 2.5% two-tailed statistical confidence interval
  - Thus it's not too surprising that the average effect is zero because salient information is rare

- But there is some interesting evidence that self-reports of doctor visits and medication usage *might have declined* among those asked to submit biomarkers
  - It's conceivable that respondents viewed biomarker collection as a substitute for a blood test or (biannual!) physical
  - It's also possible that the news they received was more positive than they expected it to be

Overview of results (2/4)

- But among those who received notifications of outside-normal-range biomarkers, average treatment effects on these treated participants were significant, sometimes large, and interesting

  - Effects stemmed typically from "rare and deadly" High BP Card and High A1c, not as much for "common and mundane" high BP and high total cholesterol

  - These ATET effects usually differed between subgroups based on their preexisting knowledge (diagnosis) of the underlying disease

    - But not all reactions were specific to the previously undiagnosed!

  - Spouses' notifications of rare and deadly conditions sometimes triggered significant responses

    - Households appeared to be reacting to the news, which could explain why effects existed for "noncompliers" who already knew they had the disease

- Reactions ranged from the obvious (new diagnosis) to less (weight loss)

Overview of results (3/4)

- For those with either the High BP Card or high A1c and without a doctor's diagnosis of the disease:
  - Increases in physicians' diagnoses of the disease & in usage of associated medications were 20–40%, compared to baseline increases of around 3–5%
  - Although large for these few, these are still neither 100% nor widespread
- Among those with High BP Card who already had a high BP diagnosis:
  - About a 5% extra increase in new diagnoses of heart problems and of stroke
  - 2.3% decline in cigarette smoking, a reduction of around a fifth
  - Signs of a reduction in own binge drinking; *and the spouse also reduces binge drinking, by a little more*
  - A *reduction* in frequency of light exercise a.k.a. household chores

Overview of results (4/4)

- Among "new diabetics" who had high A1c without a diabetes diagnosis:
  - Self-reported weight loss of 2.2%, reductions in drinking days, increased frequency of moderate and light exercise, reductions in disability
  - Spouse also reports increased frequency of light exercise and reductions in disability
- Among "old diabetics" who had high A1c with a diagnosis of diabetes:
  - Increased disability and worsened self-reported health
  - Spouse reports own weight loss of 1.5%
    - HRS does not measure diet, but given no increase in spouse's exercise here, a change in household diet is a plausible cause