HEDG
HEALTH, ECONOMETRICS AND DATA GROUP
THE UNIVERSITY of York

WP 11/11

Beware of Being Unaware: Racial Disparities in Chronic Illness in the US

Pinka Chatterji
Heesoo Joo
Kajal Lahiri

July 2011

york.ac.uk/res/herc/hedgwp

BEWARE OF BEING UNAWARE:
RACIAL DISPARITIES IN CHRONIC ILLNESS IN THE U.S.

Pinka Chatterji, Heesoo Joo, and Kajal Lahiri*

Department of Economics, University at Albany: SUNY

July 1, 2011

ABSTRACT

We study racial/ethnic disparities in awareness of chronic diseases using biomarker data from the 2006 HRS. We explore two alternative definitions of awareness, and estimate a 3-step sequential model which accounts for selection along measured and unmeasured factors into: (1) participating in biomarker collection, (2) having illness (hypertension or diabetes), and (3) being aware of illness. Our findings suggest that current estimates of racial/ethnic disparities in chronic disease are sensitive to selection, and also to the definition of disease awareness that is used. Contrary to prior studies reporting that African-Americans are more aware of having hypertension than non-Latino whites, we do not find this conclusion to be true after self-selection and severity are considered. Likewise, prior studies show mixed evidence of racial/ethnic disparities in awareness of diabetes, but after accounting for selection, we find that African-Americans and Latinos are less aware of having diabetes compared to non-Latino whites. These findings are based on a widely used definition of awareness – the likelihood of self-reporting disease among those who have disease. When we use an alternative definition of awareness, which considers an individual to be unaware if s/he actually has the disease but self-reports not having it, we find striking racial/ethnic disparities in awareness.

This research was supported by the National Institute on Minority Health and Health Disparities, National Institutes of Health (grant number 1 P20 MD003373). The content is solely the responsibility of the authors and does not represent the official views of the National Institute on Minority Health and Health Disparities or the National Institutes of Health. The HRS 2006 Biomarker data is sponsored by the National Institute on Aging (grant number NIA U01AG009740) and was conducted by the University of Michigan.

We thank Adrian Pagan, Lawrence Schell and David Strogatz for some comments and suggestions, but retain the responsibility for any errors and shortcomings in the paper.

*Correspondence to: Kajal Lahiri, Department of Economics, University at Albany, SUNY, Albany, NY 12222, USA. E-mail: klahiri@albany.edu

I. Introduction

Numerous studies show that African-Americans and Latinos are more likely than non-Latino whites to develop and have adverse consequences related to chronic health conditions such as heart disease, cancer, diabetes, arthritis, obesity, and hypertension (see NHDR 2003 for a review). Racial/ethnic disparities in chronic diseases can result from a variety of mechanisms, including differences across groups in access to effective medical care, insurance status, SES, geography, and patient/provider interactions (LêCook et al. 2010; Alegria et al. 2002; Balsa et al. 2005; Balsa and McGuire 2003; Chandra and Skinner 2004). Recent work suggests that factors related to health knowledge and information also contribute to health disparities (Cutler and Lleras-Muney 2010; Aizer and Stroud 2010; Goldman and Lakdawalla 2005). If patient-level factors such as therapy compliance or behavioral response to health information vary across groups, these differences ultimately may lead to disparities in effective treatment and health outcomes even when groups have equal access to medical care.

Early awareness of having a chronic health condition is another aspect of health knowledge that influences an individual's ability to manage the progression of a disease, and may contribute to health disparities. Without early preventative intervention, the course of a chronic disease is a continuum from the disease-free state to asymptomatic biological change, clinical illness, impairment, disability and ultimately death. In the present study, we examine whether there exist racial/ethnic disparities in the awareness of two highly prevalent, costly chronic diseases that are typically asymptomatic in their early stages -- diabetes and hypertension. Currently, the total direct and indirect costs in the US due to these two health conditions exceed $250 billion.

We use new, state-of-the-art data from the Health and Retirement Study (HRS), which includes biomarkers for diabetes and measurement of hypertension. We build on prior work by accounting for the possibility that there are factors (both observed and unobserved) that drive an individual's choice to participate in the medical examination portion of the HRS survey, the likelihood the individual has chronic health conditions, and the probability that the individual is aware of having a chronic health condition if s/he does indeed have one. As we discuss below, these factors are likely to be correlated with race/ethnicity, and thus may obscure the identification of racial/ethnic disparities in awareness of chronic conditions if we do not adjust for them. In contrast to recent research, which indicates that African-Americans are more aware of having hypertension than non-Latino whites, our findings suggest that while relatively more African-Americans currently receive treatment for this illness, disproportionately more African-Americans are still not aware of having the condition compared to individuals from other racial/ethnic groups. With respect to diabetes, a similar situation exists.

II. Background

Recent studies examining racial/ethnic differences in awareness of chronic disease show mixed findings, with some results related to hypertension showing greater awareness among minorities compared to non-Latino whites (Hertz et al. 2005; Ong et al. 2007; Howard et al. 2006; Danaei et al. 2009; Pierce et al. 2009). However, several empirical challenges arise in estimating racial/ethnic disparities in disease awareness. First, individual-level factors such as disease severity and health status may confound an observed association between race/ethnicity and awareness in a cross-sectional sample. Hertz et al. (2005) and Ong et al. (2007), for example, find that African-Americans who objectively meet criteria for hypertension are more likely to be aware of their condition than non-Latino whites. The models, however, do not adjust for health status and severity of disease. As a consequence, the results may reflect the fact that African-Americans at a particular age simply are more likely than non-Latino whites to have advanced, symptomatic disease, and, as a result, are more likely to be under treatment and be aware of the disease. If that is the case, greater awareness of disease observed in the sample is not necessarily indicative of the same in the remaining untreated population.

Moreover, awareness status is known only for those who objectively meet criteria for disease. That is, one cannot observe whether a healthy person would be aware of his disease if s/he had the disease. This censoring issue potentially confounds estimates of disparities in prior work. For example, Howard et al. (2006) adjust for observable aspects of severity using a logistic regression model, and still find that African-Americans are more likely to be aware of having hypertension compared to non-Latino whites. However, this approach does not account for the possibility that unmeasured aspects of health status and health behaviors may be correlated with race/ethnicity, and also related to both the likelihood of having the disease and the likelihood of being aware of the disease if it exists. This issue may confound estimates of racial/ethnic disparities in unawareness.

Most recently, Johnston et al. (2009), using the Health Survey for England (HSE), examine the income/health gradient using self-reported and objective measures of hypertension. They estimate a censored bivariate probit model to account for the possibility that measured and unmeasured factors may affect both an individual's propensity to meet objective criteria for hypertension and an individual's likelihood of misreporting his hypertension status (what we term "being unaware" in our study). The findings show that income is negatively related to misreporting hypertension status, but they do not find evidence of racial/ethnic disparities (Johnston et al. 2009).

In the present study, we estimate racial/ethnic disparities in health awareness among older individuals in the US and build on prior work in four ways. First, we take advantage of the rich data available in the HRS to adjust for a range of individual-level factors that may be correlated with both race/ethnicity and awareness, including disease severity. Second, we consider two alternative definitions of disease awareness. The standard definition classifies an individual as aware if s/he self-reports having a disease conditional on actually having the disease based on a medical exam. We use this definition, as well as consider a plausible alternative one – whether an individual actually has a disease based on a medical exam conditional on self-reporting not having a disease. This latter definition may be particularly useful when using large-scale surveys to target under-served populations.

Third, like Johnson et al. (2009), we account for the possibility that factors exist which affect both the likelihood of having chronic illness and the likelihood of being aware of the illness if it exists. By jointly estimating equations modeling the probability of having the illness and the probability of being aware of the illness if it exists, we can account for measured and unmeasured variables that may confound an observed association between race/ethnicity and awareness. We apply this method using data from the US, while Johnson et al. (2009) uses data from England and focuses on the income/health gradient.

Finally, our fourth contribution is that we take into account a second form of censoring that may be particularly important in the estimation of racial/ethnic disparities - - censoring that results from respondents refusing to participate in the collection of health examination and biomarker data. We only observe objective and self-reported measures of chronic illness (and thus unawareness status) for HRS respondents who: (1) agree to participate in the collection of health examination and biomarker data; and (2) provide a self-report about chronic illness. We allow for the possibility that individuals select into survey participation along measured and unmeasured factors that also affect the existence of disease and awareness of disease if it exists.

As discussed below, participation in the HRS biomarker data collection effort involves a medical examination, which includes blood pressure measurement and a blood draw. Many factors may affect an individual's decision to participate in the medical examination, and some of these factors are also likely to affect disease prevalence and awareness. For example, an individual who has strong mistrust of the health care system may be reluctant to participate in the medical examination, and also may be more likely to have chronic illness and more likely to be unaware of it if it exists. On the other hand, an individual who is knowledgeable about health may be both more likely to participate in the medical examination, less likely to have illness, and more likely to be aware of it if it exists. Unmeasured factors underlying participation decisions, disease prevalence, and disease awareness may be associated with race/ethnicity and SES, potentially obscuring estimation of disparities if we do not account for them empirically.[1]

III. Data, Definitions, and Sample Statistics

A. The Health and Retirement Study

Data for this study come from the 2006 Health and Retirement Study (HRS), a biannual, nationally representative, longitudinal household survey initiated in 1992 with a sample of households in which the household heads were 51 to 61 years old. The 2006 HRS core interview included an enhanced face-to-face interview with a medical examination by a trained interviewer.

[1] In the case of African-Americans, there is a well-documented history of mistrust of medicine and medical research, stemming in part from the Tuskegee Syphilis Study and other violations of medical ethics in the US that were targeted at minority patients (LaVeist et al., 2000; Achter et al., 2005; and Halbert et al., 2009). For all minority groups, culture, language, immigration status, education, and health knowledge are just some of factors that may affect participation in the HRS biomarker data collection as well as disease and awareness of disease.

The medical examination involved measurement of height, weight, mobility, strength, blood pressure, and lung capacity, as well as collection of biomarker data through saliva and blood samples. The sampling process used for the enhanced interview is as follows. First, the HRS randomly assigned half of the households in the 2006 Core sample to an enhanced face-to-face interview in 2006. Among those respondents who were assigned to an enhanced face-to-face interview in 2006 (N=9,570), the HRS excluded respondents who were living in a nursing home, who chose a proxy interview, or who chose a phone interview (12.4 percent of the 2006 enhanced face-to-face interview sample). Based on this process, 8,379 respondents in 2006 (45.4% of the entire HRS 2006 sample) were eligible for an enhanced interview which involved a medical examination. However, our analysis sample includes 8,051 respondents because 328 respondents had missing data for one of more variables we use in the analysis.

Table 1 shows the un-weighted mean characteristics for the analysis sample and also by refusal/acceptance status in the extended medical exam for both hypertension and diabetes. Among HRS respondents who were eligible for the enhanced interview, some respondents refused to participate in the medical examination and/or blood draw, or could not provide usable information from the medical examination. There was a separate consent process for the saliva and blood draws that was conducted just before the samples were collected. Respondents only participated if they affirmed both that they understood the directions and that they felt safe participating. "Agreed to participate" in our sample includes eligible respondents who agreed to participate in the medical examination and provided usable data from the medical examination. "Refused to participate" includes those respondents who refused, as well as those who accepted the medical examination but provided unusable measurements. For hypertension, 537 respondents who smoked, exercised, or consumed alcohol or food within the 30 minutes prior to completing the blood pressure measure could not provide usable measurements of blood pressure.

If the respondents in the refusal group have very similar observable characteristics as respondents in the acceptor group, it would be less likely that a sample selection problem exists that would affect our estimates of racial/ethnic disparities. In the case of hypertension, which involves a physical measurement of blood pressure status (described in more detail below), the refusal group disproportionately includes African-Americans and respondents with low income, less education, and poor health. The same general pattern is true for diabetes, which involves a blood draw. This result differs from Johnston et al. (2009), who report no selection problem with regard to agreeing to participate in measurement of chronic illness. However, in our case, Table 1 strongly suggests the existence of a self-selection problem in the 2006 HRS that must be addressed in the estimation of racial/ethnic disparities.

B. Measurement of chronic illness: hypertension and diabetes

The HRS asks respondents to provide a self-report of hypertension and diabetes. If a respondent is new in the 2006 wave, the respondent is asked "*Has a doctor ever told you that you have high blood pressure or hypertension [diabetes]?*" If a respondent participated in a prior HRS wave and reported hypertension (diabetes) in the last interview, the interviewer asks her/him whether s/he wishes to dispute the prior report of illness. If not, the respondent is asked whether s/he currently takes medication for hypertension (diabetes).

If a respondent participated in a prior HRS interview but did not report hypertension (diabetes), the respondent is asked "*Since we last talked to you, has a doctor told you that you have high blood pressure or hypertension [diabetes]?*" If the respondent reports high blood pressure or hypertension (diabetes) in the current period, s/he is asked a follow-up question about whether s/he takes any medication for the illness.[2] In Table 2, we see that 56 percent of our sample self-reports hypertension and 50 percent reports currently taking medication for hypertension. Table 2 also shows that 20 percent of our sample reports having diabetes and 17 percent reports taking medication for diabetes.

The HRS enhanced interview included measurement of each consenting participant's systolic blood pressure (SBP) and diastolic blood pressure (DBP), which we consider to be objective measurement of hypertension. The blood pressure reading was taken three times during the interview. We use the mean of the 2nd and the 3rd readings of systolic blood pressure and diastolic blood pressure (Johnston et al. 2009). Based on standard definitions (see Hertz et al. 2005; Morenoff et al. 2007; Angell et al. 2008; Johnston et al. 2009), we consider a person to be hypertensive if s/he has over 140 mmHg systolic blood pressure (SBP) or over 90 mmHg diastolic blood pressure (DBP). The HRS enhanced interview also included a blood draw and blood analysis. As an objective measure of diabetes, we use the A1C level, a measure of the average glucose level in the respondent's blood over the past 2-3 months.[3] Following guidelines from the American Diabetic Association, we consider an A1C of higher than 6 percent to be an indicator of diabetes (Buell et al. 2007; Ginde et al. 2008).

As seen in Table 2, 32 percent of our sample meets objective criteria for hypertension and 24 percent meets objective criteria for diabetes. Note that these individuals have uncontrolled or undiagnosed disease – that is, these individuals include both who are aware of their disease but

[2] This question structure has the advantage of reducing the likelihood of false-positive reporting due to 'no longer having the illness' since the data is updated every two years. Even though hypertension or diabetes is very unlikely to be completely cured, there is the possibility of complete recovery due to proper management. Update of the status every two years certainly reduces the likelihood of this kind of error.

[3] One merit of the A1C test is that test results are insensitive to the timing of measurement and show broad shot of an individual's diabetes status. A normal A1C for people without diabetes is 4-6 percent. However, A1C level is not usually used for the diagnosis of diabetes but rather used for checking blood sugar level among diagnosed diabetes patients.

have not been able to effectively treat it, as well as people who are unaware that they have the illness. These rates, however, would not include individuals who have the disease but who are being treated effectively with medication and/or lifestyle changes.

Co-morbidity between chronic illnesses is common, particularly among racial/ethnic minorities. Among non-Latino whites, 18 percent have both hypertension and diabetes, compared to co-morbidity rates of 35 percent among African-Americans, and 32 percent among Latinos (not shown). The high co-morbidity among African-Americans and Latinos may reflect that African-Americans and Latinos are in worse health overall compared to non-Latino whites.

C. Definitions of awareness

Our primary definition of awareness is if conditional on having the disease as determined by medical examination, respondents self-report that they do indeed have the illness. Following a recent report of the Seventh Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC7 2003) and previous studies (Hertz et al. 2005; Primatesta and Poulter 2006; Morenoff et al. 2007; Angell et al. 2008), our criteria for "having the disease" is if the respondent meets objective measurement criteria (e.g., has uncontrolled illness) and/or the individual self-reports taking medication for the disease. We include individuals who are taking medication as being part of the disease group because many respondents in our sample have disease that is controlled by medication.[4]

Table 2 shows descriptive statistics for disease prevalence and disease awareness. Among those with hypertension, 83 percent of respondents are aware of having hypertension,

[4] For example, in our sample, among those who report taking medication for hypertension, 63 percent have normal blood pressure measurement and, among those who report taking medication or using insulin pump for diabetes, 25 percent have normal blood sugar measurement.

and, among those with diabetes, 64 percent of respondents are aware of having diabetes.[5] We see in Table 2 that awareness of hypertension is 83 percent for non-Latino whites, 88 percent for African-Americans and 83 percent for Latinos. These findings show that awareness is higher among African-Americans compared to non-Latino whites, which is consistent with previous studies (Hertz et al. 2005; Ong et al. 2007). For diabetes, awareness is 63 percent for non-Latino whites, 64 percent for African-Americans and 67 percent for Latinos. This result, which shows small differences in awareness between racial and ethnic groups for diabetes, is also consistent with previous studies from NHANES data (Danaei et al. 2009, Pierce et al. 2009).

Our main definition of awareness follows the epidemiological literature in this area, which considers an individual to be aware if s/he meets the "gold standard" criteria for disease (based on objective measurement and usage of medication) and conditional on this fact, self-reports having the disease. It is best understood in the context of the schematic diagram depicting the flow of HRS respondents through the medical examination and self-reports (Figure 1a). The absolute counts and the percentages are also reported at each stage yielding the unawareness rates of 17% for hypertension and 38% for diabetes under Group C. In Table 3a, we present a cross-classification table between self reports and medical examination reports. In the context of this contingency table, awareness is defined as {a/a+c}, which is the *sensitivity* of self-reports. In our sample, about 7 percent give false-positives for hypertension and about 3 percent give false positives for diabetes.[6]

---

[5] In Table 3 in Chatterji et al. (2010), we compare the weighted versions of these rates to published rates based on NHANES respondents over 60 years old.

[6] These cases can arise if, following a doctor's report, the individual is controlling the disease by diet, exercise and other healthy lifestyle changes such that the actual medical examination does not identify the disease. In addition some errors in measurement can never be ruled out, particularly in case of hypertension.

Note that this standard measure of awareness completely ignores the *specificity* of self reports, i.e., given that the medical examination has determined that the subject does not have the disease, the probability that the self report concords with the test result. An alternative definition of awareness may be more appropriate in certain cases, and can help public health officials to identify high risk populations for early testing. In particular, the alternate definition of awareness could be the following: conditional on self-reporting not having the disease, a respondent, based on objective measurement, is found not to have the disease, i.e., $b2/(b2+c)$ in Table 3a. The proportion of unaware using this definition is $c/(b2+c)$. The two alternative measures of unawareness will give similar estimates if a and $b2$ are similar in magnitude. On the other hand, in cases where $b2$ is considerably bigger (smaller) than a, this alternative measure will yield a smaller (bigger) incidence of unawareness. The model structure underlying this alternate definition of (un)awareness is mapped out in Figure 1b, and the incidence of unawareness for different race/ethnic groups based on our sample are reported in Table 3b. What is remarkable in Table 3b is that with the alternative definition, the percentage unaware is relatively much higher for the minorities compared to non-Latino whites. For instance, the unaware percentage for diabetes is only 11 percent for non-Latino whites but over 20 percent for African-Americans and Latinos. For hypertension, even though for Latinos it makes no difference, the rate is 23 percent for non-Latino whites but 34 percent for African-Americans.

The intuition behind this result can be derived from the way we slice the data in two alternative sequential patterns as depicted in Figures 1a and 1b. Note that prevalence includes both objectively measured disease and/or medication use. In Figure 1a, at step 3, a large portion of the aware group (viz. Group A) includes people who are under treatment and take medication to control their illness. By contrast, at step 3 of Figure 1b, neither of the two groups is on medication. These are the patients who reported in the survey that they were never told by a doctor of the existence of either hypertension or blood pressure, yet the medical examination determined that a portion of them in fact had the disease. Thus, in the alternative definition of awareness, the people who are on medication are not included. However, in our sample we found (cf. Table 2) that a disproportionately large number of African-Americans are on hypertension medication (65% African-Americans, 47% Latinos, and 48% non-Latino whites). Thus, even though a larger proportion of African-Americans are treated with hypertension medication than non-Latino whites, there are even a larger number of undiagnosed African-American patients who are unaware of their disease. With respect to diabetes patients, while only 14% of non-Latino whites are on medication, the percentages are 25% for African-Americans and 27% for Latinos. However, Table 3b reveals that even then the incidence of unawareness for diabetes among the remaining minorities is almost double that of non-Latino whites. The fact that a higher percentage of minorities are on medication is simply reflective of the reality that these groups are more extensively and severely impaired by the chronic diseases, possibly due to initial period unawareness, lack of early treatment, and the resultant progression to the latter stages of the disease. The alternative definition of unawareness leads us to realize that the conventional definition of awareness can sometimes be misleading about the true level of awareness in the untreated population.

D. Concordance between "self-reports" and "medical examinations"

Two types of mismatches between self reports and medically-tested objective measurements are possible – an individual may fail to a report a disease that exists, or an individual may incorrectly report a disease that does not exist (see Table 3a). If there are a reasonably small number of mismatched cases, the self-reported information has strong power to predict actual chronic health conditions, and there is little room for improvement in the awareness of chronic conditions. In this section, we examine whether this is the case, and we also test whether the mis-match between self-reports and objective measurements differs by race/ethnicity.

We first proceed with Pearson's bellwether test in a contingency table by calculating the index of concordance $\hat{I} = \frac{1}{N}\{\sum_{i=1}^{N} y_{pi}\, y_{si} + \sum_{i=1}^{N}(1 - y_{pi})(1 - y_{si})$ where y_{pi} = 1 if individual *i* is truly in the disease group and 0 otherwise, and y_{si} = 1 if the same individual *i* self-reports having the disease and 0 otherwise. We test the null hypothesis $H_0\colon \hat{I} = 1$ which means that y_{pi} and y_{si} are completely dependent. Table 4 presents estimated indices $\hat{I}$, and associated t-test statistics by race/ethnicity. For both hypertension and diabetes, indices of concordance by each racial/ethnic group are significantly different from one (hypertension: 0.86-0.88, and diabetes: 0.83-0.89), which means that self-reports and objective measurements are not perfectly correlated.

The above test for concordance is not robust to possible heteroscedasticity in the errors. Following Harding and Pagan (2006) we also use a regression approach for testing the correlation between self-reports and medical examinations by estimating

$$\hat{\sigma}_{si}^{-1} y_{si} = a + \rho \hat{\sigma}_{pi}^{-1} y_{pi} + u_i\,, \qquad (1)$$

where u_i is the error term, and $\hat{\sigma}_{si}\, and\ \hat{\sigma}_{pi}$ are the sample estimates of the standard deviations of y_{si} and y_{pi}, respectively. One advantage of this approach is that statistical inference on ρ can be made without assuming that $u_i\ is$ i.i.d. The estimates of ρ together with their heteroscedasticity-consistent standard errors are presented in Table 4. The Wald tests based on regression (1) again reveal that the correlation is significantly less than one for all racial groups and for both hypertension and diabetes.

Even though these tests are appropriate for testing complete dependency, they do not provide information regarding whether the incomplete dependency comes from false-negative or false-positive reporting, since both types of misreporting decrease the concordance index. Benitez-Silva et al. (2004) propose an alternate way to test for complete dependency that has the advantage of being able to distinguish the effects of false-positives and false-negatives. This is because the procedure amounts to regressing $y_p - y_s$, which has a different sign for reporting a false-positive and a false-negative, on a constant term and racial/ethnic dummies. The results in Table 4 show the constant term is significantly positive, which indicates that there are more people reporting false-negatives compared to false-positives, and this is true for both hypertension and diabetes. The significantly positive coefficients on the racial/ethnic dummy variables for diabetes support the idea that non-Latino whites are more aware of diabetes than African Americans and Latinos. For hypertension, the race-ethnic dummies are not statistically significant at even 10% significance level.

In sum, the analysis in this section suggests that the mismatch between self-reports and objective measures of chronic illness in HRS is not ignorable. In the case of hypertension, the dependency is not significantly different by race/ethnicity, but for diabetes, the match is significantly higher among non-Latino whites compared to African-Americans and Latinos. In the sections that follow, we focus on racial/ethnic disparities in false-negative reporting (e.g., unawareness) of chronic illness that will also correct for possible sample selection problems and other confounders.

IV. Model and Methods

As introduced in Figure 1a, our standard definition of awareness implies a 3-step sequential model in which HRS respondents potentially may be screened out at three steps. Figure 1a maps out this model with sample sizes at different levels separately for hypertension and diabetes. In the first step, HRS respondents either agree to participate in the medical examination or they refuse; if they refuse, they are screened out at this stage since we do not have information on whether or not they have the disease (Figure 1, Step 1: Agreed to participate in medical exam). In the second step, HRS respondents who participate either have the disease based on objective criteria or they do not (Figure 1, Step 2: Have disease). At this stage, respondents who do not have the disease are screened out since we cannot observe what their awareness status would have been if they had the disease. Finally, in the third step, among those who have the disease, we can ascertain awareness of disease status based on the respondent's self-report of illness (Figure 1, Step 3: Aware of disease). Respondents who self-report that they have the disease are aware, and those who self-report not having the disease are unaware of illness.

Essentially, we observe four mutually exclusive outcomes, labeled *A*, *B*, *C* and *D* in Figure 1. The sets of sample individuals belonging to these outcomes are denoted by *a*, *b*, *c*, and *d* respectively. The outcome D includes respondents who do not agree to participate $(h_1 = 0)$, and the outcome B includes respondents who agreed to participate and do not have the disease $(h_1 = 1, and\ h_2 = 0)$. The outcome C includes respondents who agreed to participate, have the disease, and are not aware of the disease $(h_1 = 1, h_2 = 1, and\ h_3 = 0)$, and finally, outcome A includes respondents who agreed to participate, have the disease, and are aware of the disease

$(h_1 = 1, h_2 = 1, and\ h_3 = 1)$. Although we observe the binary outcome h_i, the underlying latent variable h_i^* can be expressed as follows:

$$h_{ij}^* = \beta_i' x_{ij} + \varepsilon_{ij} \qquad (2)$$

for i=1,2, and 3. The vector x_i represents individual characteristics at step i, and j are individuals. We call i=1 the "acceptance" step (i.e., agreed to the medical examination), i=2 the "incidence of disease" step and i=3 the "awareness" step. For i=1, h_{1j} equals 1 if $h_{1j}^* \geq 0$ and h_{1j} equals 0 otherwise. For i=2 and3, h_{ij} equals 1 if $h_{ij}^* \geq 0, and\ h_{kj}^* \geq 0$ with all k<i and otherwise h_{ij} equals 0. The probabilities of each outcome are written as:

$$\Pr(D) = \Pr(h_{1j}^* < 0) = \Phi(-\beta_1' x_{1j}) \qquad (3)$$

$$\Pr(B) = \Pr(h_{1j}^* \geq 0, and\ h_{2j}^* < 0) = \Phi_2(\beta_1' x_{1j}, -\beta_2' x_{2j}, \Omega_2) \qquad (4)$$

$$\Pr(C) = \Pr(h_{1j}^* \geq 0, h_{2j}^* \geq 0, \text{and } h_{3j}^* < 0) = \Phi_3(\beta_1' x_{1j}, \beta_2' x_{2j}, -\beta_3' x_{3j}, \Omega_3) \qquad (5)$$

$$\Pr(A) = \Pr(h_{1j}^* \geq 0, h_{2j}^* \geq 0, \text{and } h_{3j}^* \geq 0) = \Phi_3(\beta_1' x_{1j}, \beta_2' x_{2j}, \beta_3' x_{3j}, \Omega_3) \qquad (6)$$

where the errors $(\varepsilon_1, \varepsilon_2, \varepsilon_3)$ are assumed to be normally distributed with mean zero and correlation matrix $\Omega_3 = \begin{pmatrix} 1 & & \\ \rho_{21} & 1 & \\ \rho_{31} & \rho_{32} & 1 \end{pmatrix}$. Ω_2 is the 2x2 sub-matrix involving ρ_{21}. The joint log-likelihood function is given by:

$$L = \sum_{j \in d} \ln P\{h_{1j}^* < 0\} + \sum_{j \in b} \ln P\{h_{1j}^* \geq 0, and\ h_{2j}^* < 0\}$$

$$+ \sum_{j \in c} \ln P\{h_{1j}^* \geq 0, h_{2j}^* \geq 0, and\ h_{3j}^* < 0\}$$

$$+ \sum_{j \in a} \ln P\{h_{1j}^* \geq 0, h_{2j}^* \geq 0, and\ h_{3j}^* \geq 0\} \qquad (7)$$

Like many sequential response models, however, we have unequal number of observations across steps. This gives rise to a multivariate probit model with partial observability. As a result, the summation of the log-probability for each outcome is taken only over the sample cases that have attained that final outcome, as denoted by the sets *d, b, c,* and *a*. The evaluation of the log-likelihood function L in general involves higher-dimension multiple integrals of normal rectangle probabilities unless Ω assumes a simplified structure. We use GHK Monte Carlo simulator to simulate the probabilities and evaluate the log-likelihood function.[7] Note that in expression (7), each of the integration of the probabilities for different outcomes involves only a top-left subset of Ω, depending on the dimension of the integral. The advantage of the 3-step sequential probit model is that we can maximize a joint likelihood function.

Obviously, when Ω is an identity matrix, the log-likelihood function in (7) is equivalent to that of a 3-stage step-wise sequential probit model:

$$L = (\textstyle\sum_{j\in d} \ln P\{h_{1j}^* < 0\} + \sum_{j\in b\cup c\cup a} \ln P\{h_{1j}^* \geq 0\})$$
$$+ (\textstyle\sum_{j\in b} \ln P\{h_{2j}^* < 0\} + \sum_{j\in a\cup c} \ln P\{h_{2j}^* \geq 0\})$$
$$+ (\textstyle\sum_{j\in c} \ln P\{h_{3j}^* < 0\} + \sum_{j\in a} \ln P\{h_{3j}^* \geq 0\}) \qquad (8)$$

Note that the expressions inside each pair of parentheses are independent of each other and may be evaluated separately. However, it is reasonable to assume that common unmeasured individual factors including possible subjectivity in the underlying response scale exist which affect the errors in all equations. The proclivity to gather and use health knowledge, for instance, may be difficult to measure but it may affect both the 2nd and 3rd steps, by decreasing prevalence and increasing awareness of chronic illnesses. Also, this factor may affect the 1st step by

[7] We used the GAUSS code provided by Hajivassiliou, McFadden and Ruud (1996).

increasing the likelihood of participating in the medical examination. Thus, we need to maximize joint likelihood function instead of maximizing separate likelihood functions.

The equations also embody certain natural exclusion restrictions. Specifically, we include three binary variables related to the HRS respondent's behavior during the interview in the "acceptance" step, but were not significant in the "disease" and "awareness" steps. These three variables are the HRS interviewer's observations about: (1) whether the respondent appeared hostile during the interview; (2) whether the respondent was uncooperative during the interview; and (3) whether the respondent expressed concerns about time during the interview. The HRS respondent's attitude during the interview is likely to influence whether the respondent agrees to participate in the medical examination, a more invasive and time-intensive portion of the interview. However, the respondent's attitude during the HRS interview should not be directly related to disease and disease awareness, after controlling for other factors.

In addition, measures of obesity and overweight status are included only in the "has disease" equation, and not in the "acceptance" and "awareness" steps. This exclusion is reasonable since body weight has physiological influence on the likelihood of having disease but does not directly affect awareness of disease and participation in the interview, after controlling for other factors. Since obesity is a major risk factor for hypertension and diabetes, this restriction is reasonable. The second restriction that obesity does not affect the awareness of chronic conditions may seem less reasonable. Obesity could affect awareness of chronic conditions if obese individuals have more opportunities to have blood pressure and/or blood sugar level measurement because of their bodyweight. However, obesity was insignificant in the awareness level possibly because of other controls including self-assessed health and co-morbidity in the specification.

In order to establish the importance of self-selection and other unmeasured factors, we need to test for the significance of non-diagonal terms in the correlation matrix of disturbances in the hypertension and diabetes models. We amended an LM test statistic for a diagonal correlation matrix (Ω=I) in a multivariate probit model originally proposed by Kiefer (1982) for our sequential model.[8]

V. Empirical Results

Tables 5 and 6 report the simulated maximum likelihood (SML) estimates using the GHK simulator for the three-step sequential probit model for hypertension and diabetes respectively.[9] In both tables, Panel 1 shows estimates from the first stage (agreed to participate in the medical exam), Panel 2 shows estimates from the second stage (has the disease, among those who agreed to participate), and Panel 3 shows estimates from the third stage (aware of disease, among those who agreed to participate and also have the disease). The final rows of each table show estimates of the ρs, the estimated correlations between unmeasured factors affecting the outcomes of interest. In both Tables 5 and 6, our primary interest is in the estimated coefficients on the race/ethnicity indicators and their marginal effects in Panel 3 of each table, since these indicators provide information on the significance and direction of racial/ethnic disparities in

[8] For the 3-step sequential probit model, the LM statistic is as follows:

$$LM=\frac{g_{12}^2}{k_{12}}+\frac{g_{23}^2}{k_{23}}+\frac{g_{13}^2}{k_{13}}\sim\chi_3^2,$$

where $g_{lm}=\sum_{i=1}^{n} q_{il}\, q_{im}\frac{\varphi(w_{il})\varphi(w_{im})}{\Phi(w_{il})\Phi(w_{im})}$, $k_{lm}=\sum_{i=1}^{n}\frac{(\varphi(w_{il})\varphi(w_{im}))^2}{\Phi(w_{il})\Phi(-w_{il})\Phi(w_{im})\Phi(-w_{im})}$,

$w_{im}=q_{im}z_{im}$, $q_{im}=2h_{im}-1$, and $z_{im}=\beta_m' x_{im}$, (i=1,…N and m=1,2 and 3).

[9] The normalization that the diagonal elements of Ω are unity prevents us from directly using the convenient derivatives of the multivariate normal rectangle probabilities in the GHK simulator as derived by Hajivassiliou, McFadden and Ruud (1996) to estimate standard errors. Instead, we rely on the maximum likelihood algorithm to generate standard errors for all parameters. We first used a sampling size of 50 for the GHK simulator to obtain initial estimates and then fine-tuned the estimation finally with a sampling size of 500.

health awareness. In addition, the estimated coefficients on education and income in Panel 3 of each table provide information regarding the SES gradient in health awareness.[10]

In Panel 1 of Table 5, the estimates indicate that older individuals and Latinos are more likely than others to participate in measurement of blood pressure, while those in worse self-reported health status and smokers are less likely than others to agree to have a blood pressure measurement. African-American race is not associated with participation. Individuals with self-reported diabetes are less likely to participate, perhaps because they are aware of having diabetes and regularly check their blood pressure as part of diabetes self-management. However, individuals with self-reported elevated cholesterol are more likely to participate than others. Notably, individuals who appeared to be non-cooperative, hostile, or concerned about the length of the interview (based on HRS interviewer observation) were much less likely than others to agree to have their blood pressure measured by the interviewer.

Panel 2 of Table 5 shows correlates of having hypertension, among those who participated in hypertension measurement. African-American race is associated with a 14 percentage point higher probability of being hypertensive. However, Latinos are not statistically different from non-Latino whites in their likelihood of being hypertensive. College education is negatively associated with hypertension. As expected, older age, obesity, other health chronic conditions, and worse self-reported health all are associated with having hypertension.

Finally, in Panel 3 of Table 5, we examine awareness of hypertension among those who have the disease and agreed to participate in hypertension measurement. Recent work (Hertz et al. 2005; Ong et al. 2006; Howard et al. 2007) indicates that African-Americans are more likely

[10] The conditional marginal effects are calculated generalizing formulas reported in Greene and Hensher (2010, pp.83-96) to our trivariate case.

to be aware of their hypertension than non-Latino whites. Our results, in contrast, show no statistically significant differences between racial/ethnic groups in awareness of hypertension (Table 6, panel 3). However, we note that the estimated coefficient for African-American race is large and positive with a large standard error. Surprisingly, there is no income gradient in awareness of hypertension either. We do see an awareness gradient in post-secondary education; individuals with more than 12 years of education are more likely to be aware of their hypertension compared to less educated individuals. In addition, chronic health conditions, worse self-reported health, and female gender all are associated with higher likelihood of awareness of hypertension.

Table 6 shows findings related to diabetes. Unlike hypertension, measurement of diabetes involves a blood draw, making the first stage of the model (agreed to participate in medical examination) potentially more important. Panel 1 in Table 6 indicates that African-Americans are 8 percentage points less likely than non-Latino whites to participate in the blood draw to measure diabetes. Similarly, individuals from the other race/ethnicity category are about 10 percentage points less likely to participate compared to non-Latino whites. These differences may be due to factors such as mistrust of the US health care and research system, culture, and language. However, Latinos are just as likely to participate as non-Latino whites. Age, employment, female gender, and income are all positively associated with participating, while worse self-reported health is negatively associated with participating. As in the case of hypertension, respondents who were hostile, uncooperative, or concerned about time during the HRS interview were appreciably less likely to participate in a blood draw to measure diabetes.

Panel 2 of Table 6 shows correlates of having diabetes. All minority individuals are more likely to have diabetes than non-Latino whites. Respectively, African-Americans are 13 percentage points more likely, Latinos are 18 percentage points more likely, and individuals in the other race/ethnicity category are 17 percentage points more likely to have diabetes compared to non-Latino whites. As expected, age, other chronic illnesses, worse self-reported health, and obesity are positively associated with diabetes. Higher income is associated with lower likelihood of having diabetes.

Finally, in Panel 3 of Table 6, we examine awareness of diabetes. African-Americans and Latinos are less likely than non-Latino whites to be aware of having diabetes. We find no education or income gradient in awareness of diabetes. Surprisingly, males are more likely than females, and employed individuals are less likely than non-employed individuals to be aware of having diabetes. As expected, individuals who self-report other chronic health conditions and worse overall health are more likely to be aware of having diabetes.

The estimated correlations of errors are shown in the bottom rows in Tables 5 and 6. The results indicate that for hypertension, there is a large, statistically significant, negative correlation between the error terms of the 2nd and 3rd equations (has the disease, aware of the disease). The negative correlation suggests that there are unmeasured factors which decrease the likelihood of having the disease and increase awareness of the disease if one has it. The same is true for diabetes.

For hypertension, there are no statistically significant correlations between the error terms in the first and second equations, and between the error terms in the first and third equations. In the case of diabetes, however, there is a large negative correlation between the error terms in the first and second equations. This finding suggests the existence of unmeasured factors that increase the likelihood of participating in the medical exam (which involves a blood draw in the case of diabetes), and decrease the likelihood of having the disease. The LM statistics (see footnote 10) show that we can reject null hypothesis that the errors across are uncorrelated at the 1% significance level for both hypertension (LM=168.1) and diabetes (LM=707.3).

Next, we examine the impact, if any, of the selection problem on estimates of racial/ethnic disparities in the awareness of hypertension and diabetes. In Table 7 we have consolidated relevant results for $\Omega \neq I$ from Tables 5 and 6, and report comparable estimates that we obtained when assumption $\Omega=I$ was imposed on the estimation inappropriately. We find that the estimation results under the zero correlation assumption ($\Omega=I$) and the non-zero correlation assumption ($\Omega \neq I$) are not significantly different from each other in the 1st and 2nd steps of both the hypertension and the diabetes models. This result is consistent with the estimated correlation matrix, which shows that there is zero correlation between the 1st and 2nd steps and the 1st and 3rd steps in the diabetes and hypertension models.

In the case of hypertension, Latinos are more likely to accept the medical exam than non-Latino whites, and African-Americans and other minorities are not significantly different from non-Latino whites in their acceptance of the medical exam, regardless of whether we assume $\Omega=I$ or $\Omega \neq I$. In either model, African-Americans are more likely to have hypertension compared to non-Latino whites, but Latinos and other minorities are not statistically different from non-Latino whites in disease prevalence. Similarly, assumptions about Ω do not affect estimation of racial/ethnic differences in the acceptance of the medical examination for diabetes, or the likelihood of having diabetes. In both models, African-Americans are less likely than non-Latino whites to accept the medical exam, and all minorities are more likely than non-Latino whites to have diabetes.

However, the findings in Table 7 show that accounting for selection does appear to affect estimates of racial/ethnic disparities in awareness of chronic diseases. In the case of hypertension, assuming $\Omega \neq I$ lowers the estimated coefficient on African-American race from .25 to .13 (becoming statistically insignificant), suggesting that there is an appreciable amount of bias in estimates of racial disparities in hypertension awareness that do not correct for selection. The assumption of no correlation between the error terms of the equations also leads to the finding that there are no racial/ethnic differences in awareness of diabetes, while accounting for such correlations yields large, negative associations between African-American and Latino race/ethnicity and awareness of diabetes (Table 7). In sum, the findings in Table 7 indicate that if we ignore the correlation between unmeasured determinants of accepting the medical exam, having the disease, and being aware of the disease, we tend to underestimate racial/ethnic disparities in awareness of hypertension and diabetes.

Next, we consider racial/ethnic disparities using the alternative definition of awareness described above (e.g., the likelihood of having the disease among those who self-report not having the disease). The maximum likelihood estimates for hypertension and diabetes based on the alternative definition of awareness are reported in Tables 8 and 9 respectively. The estimates of the first two equations are very similar to those of equations 1 and 3 of the main sequential model. Now the correlation in errors between the participation and awareness equations for hypertension and between medical examination and self reports are highly significant. Among those who participate in the survey and self-report not having hypertension, African-Americans are more likely to actually have the disease compared to non-Latino whites.

In the case of diabetes, all racial/ethnic minority groups are more likely to have the illness compared to non-Latino whites, conditional on self-reporting not having the illness and agreeing to participate in the medical examination. What is noteworthy is that the African American dummy in the awareness equation for hypertension, and all minority dummies in the awareness equation for diabetes are statistically significant, and suggests that these groups are more unaware of their chronic illnesses compared to non-Latino whites. The marginal effects are substantial, around 10%. These results are consistent with Table 8 and indicate that even though a higher proportion of minorities are treated for hypertension and diabetes, there are even higher proportions of minorities who are unaware of their chronic conditions, and need to be identified and medically treated.

VI. Conclusions

This paper has two broad messages for health policy: First, we show that accounting for multiple selections affects estimates of racial/ethnic disparities in awareness of chronic diseases. Allowing for a non-diagonal correlation matrix of errors in the 3-equation sequential probit model, we find no differences across racial/ethnic groups in the awareness of hypertension, but we find that African-Americans and Latinos are less likely to be aware of having diabetes than non-Latino whites. Our analysis clearly indicates that if we ignore the correlation between unmeasured determinants of accepting the medical exam, having the disease, and being aware of the disease, we tend to underestimate racial/ethnic disparities in awareness of hypertension and diabetes.

Second, we explore an alternative definition of awareness under which the unaware respondents are the ones who report in the survey that they were never told by a doctor of the existence of a disease, yet the medical examination determined that they in fact have it. Under this alternative definition, people who self-report taking medication have been logically vetted out (since by definition they self-report having the disease) while distinguishing between aware and unaware. In our sample, a disproportionate number of African-Americans and Latinos are taking medication for hypertension and diabetes. Interestingly, we find that with this alternative definition, the percentage unaware is relatively much higher for all minorities compared to non-Latino whites. Thus, even though a larger proportion of minorities are treated for hypertension and diabetes than non-Latino whites, there are even a larger number of undiagnosed African-American and Latino patients who are unaware of their chronic conditions. The fact that a higher percentage of minorities are on medication simply reflects the reality that these groups are more extensively and severely impaired.

The simulated maximum likelihood estimates of the alternative sequential probit model allowing for multiple selections suggest that the African-Americans are almost 10% less likely to be aware as non-Latino whites for hypertension, and that all minorities are significantly less aware for diabetes by a similar magnitude. Under the conventional definition of awareness, which includes people being treated by medication, the relatively large number of treated minorities gives the impression that they as a group are more aware than non-Latino whites. However, when examining the untreated, we find that significant racial/ethnic disparities persist in the awareness of hypertension and diabetes. To reduce disparities in chronic disease outcomes, future research should address improving health awareness in racial/ethnic minority and other under-served populations.

References

Achter, P., Parrott, R. & Silk, K. (2005). African Americans' opinions about human-genetics research. *Politics and the Life Sciences.* 23 (1) p. 60-66.

Aizer, A., & Stroud, L. (2010). Education, knowledge and the evolution of disparities in health. Working Paper 15840. Cambridge: National Bureau of Economic Research.

Alegria, M. et al (2002). Inequalities in use of specialty mental health services among Latinos, African Americans, and non-Latino whites. *Psychiatric Services.* 53 (12) p. 1547-1555.

Angell, S. Y. et al (2008). Prevalence, awareness, treatment, and predictors of control of hypertension in New York City. *Circulation, Cardiovascular Quality and Outcomes* [Online] 1 p. 46-53. Available from: http://circoutcomes.ahajournals.org/cgi/content/full/1/1/46 [Accessed 24/02/2010]

Balsa, A. I. & McGuire, T. G. (2003). Prejudice, clinical uncertainty and stereotyping as sources of health disparities. *Journal of Health Economics.* 22 p. 89-116.

Balsa, A. I., McGuire, T. G. & Meredith, L. S. (2005). Testing for statistical discrimination in health care. *Health Services Research.* 40 (1) p. 227-252.

Benítez-Silva, H. et al (2004). How large is the bias in self-reported disability? *Journal of Applied Econometrics.* 19 p. 649-670.

Buell, C., Kermah, D. & Davidson, M. B. (2007). Utility of A1C for diabetes screening in the 1999-2004 NHANES Population. *Diabetes Care.* 30 (9) p. 2233-2235.

Chandra, A. & Skinner, J. (2004). *Geography and Racial Health Disparities @ Critical Perspectives on Racial and Ethnic Differences in Health in Late Life.* Washington DC: National Academy Press. p. 604-640.

Chatterji, P., Joo, H. & Lahiri, K. (2010). Beware of unawareness: Racial/ethnic disparities in awareness of chronic disease. Working Paper 16578. Cambridge: National Bureau of Economic Research.

Chobanian, A. V. et al (2003). The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure (JNC 7). *Hypertension* [Online] 42 p. 1206-1252. Available from: http://hyper.ahajournals.org/cgi/content/full/42/6/1206 [Accessed 22/11/2010]

Cutler, D. M. & Lleras-Muney, A. (2010). Understanding differences in health behaviors by education. *Journal of Health Economics.* 29 p. 1-28.

Danaei, G. et al (2009). Diabetes prevalence and diagnosis in US states: analysis of health surveys. *Population Health Metrics* [Online] 7 (16). Available from: http://www.pophealthmetrics.com/content/7/1/16 [Accessed 01/03/2010].

Ginde, A. A. et al (2008). Value of risk stratification to increase the predictive validity of HbA1C in screening for undiagnosed diabetes in the US population. *Journal of General Internal Medicine.* 23 (9) p.1346-1353.

Goldman, D. P. & Lakdawalla D.N. (2005). A theory of health disparities and medical technology. *Contributions to Economic Analysis & Policy* [Online] 4 (1) Article 8. Available from: http://www.bepress.com/bejeap/contributions/vol4/iss1/art8 [Accessed 29/09/2010]

Greene, W. H. & Hensher, D. A. (2010). *Modeling ordered choices: A primer.* Cambridge: Cambridge University Press.

Hajivassiliou,V., McFadden, D. & Paul Ruud, P. (1996). Simulation of multivariate normal rectangle probabilities and their derivatives theoretical and computational results. *Journal of Econometrics*. 72 (1-2) p. 85-134.

Halbert, C. H. et al (2009). Racial differences in medical mistrust among men diagnosed with prostate cancer. *Cancer.* (June) p. 2553-2561.

Harding, D. & Pagan A. (2006). Synchronization of cycles. *Journal of Econometrics.* 132 p. 59-79.

Health and Retirement Study, 2006 Biomarker data. Produced and distributed by the University of Michigan with funding from the National Institute on Aging (grant number NIA U01AG009740). Ann Arbor, MI, (2006).

Hertz, R. P. et al (2005). Racial disparities in hypertension prevalence, awareness, and management. *Archives of Internal Medicine.* 165 p. 2098-2104.

Howard, G. et al (2006). Racial and geographic differences in awareness, treatment, and control of hypertension: The REasons for Geographic and racial differences in stroke study. *Stroke* [Online] 37 (5) p. 1171-1178 Available from: http://stroke.ahajournals.org/cgi/content/full/37/5/1171 [Accessed 28/04/2010]

Johnston, D. W., Propper C. & Shields M. A. (2009). Comparing subjective and objective measures of health: Evidence from hypertension for the income/health gradient. *Journal of Health Economics.* 28 p. 540-552.

Kiefer, N. M. (1982). Testing for dependence in multivariate probit models. *Biometrika*. 69 (1) p. 161-166.

LaVeist, T. A., Kim, N. J. & Bowie J. V. (2000). Attitudes about racism, medical mistrust, and satisfaction with care among African American and White cardiac patients. *Medical Care Research and Review*. 57 Suppl1 p. 146-161.

LêCook, B. et al (2010). Comparing methods of racial and ethnic disparities measurement across different settings of mental health care. *Health Services Research.* 45 (3) p. 825-847.

Morenoff, J. D. et al (2007). Understanding social disparities in hypertension prevalence, awareness, treatment, and control: The role of neighborhood context. *Social Science & Medicine.* 65 p. 1853-1866.

National Healthcare Disparities Report (NHDR), 2003. Full Report. Agency for Healthcare Research and Quality, Rockville, MD. Available from: http://www.ahrq.gov/qual/nhdr05/index/html [Accessed 19/11/2010]

Ong, K. L. et al (2007). Prevalence, awareness, treatment and control of hypertension among United States adults 1999-2004. *Hypertension* [Online] 49 p. 69-75. Available from: http://hyper.ahajournals.org/cgi/content/full/49/1/69 [Accessed 27/04/2010]

Pierce, M. B. et al (2009). Undiagnosed diabetes - data from the English longitudinal study of ageing. *Diabetic Medicine.* 26 p. 679-685.

Primatesta, P. & Poulter, N. R. (2006). Improvement in hypertension management in England: results from the Health Survey for England 2003. *Journal of Hypertension.* 24 (6) p. 1187-1192.

Figure 1a: Flow chart depicting awareness of chronic diseases, 2006 HRS

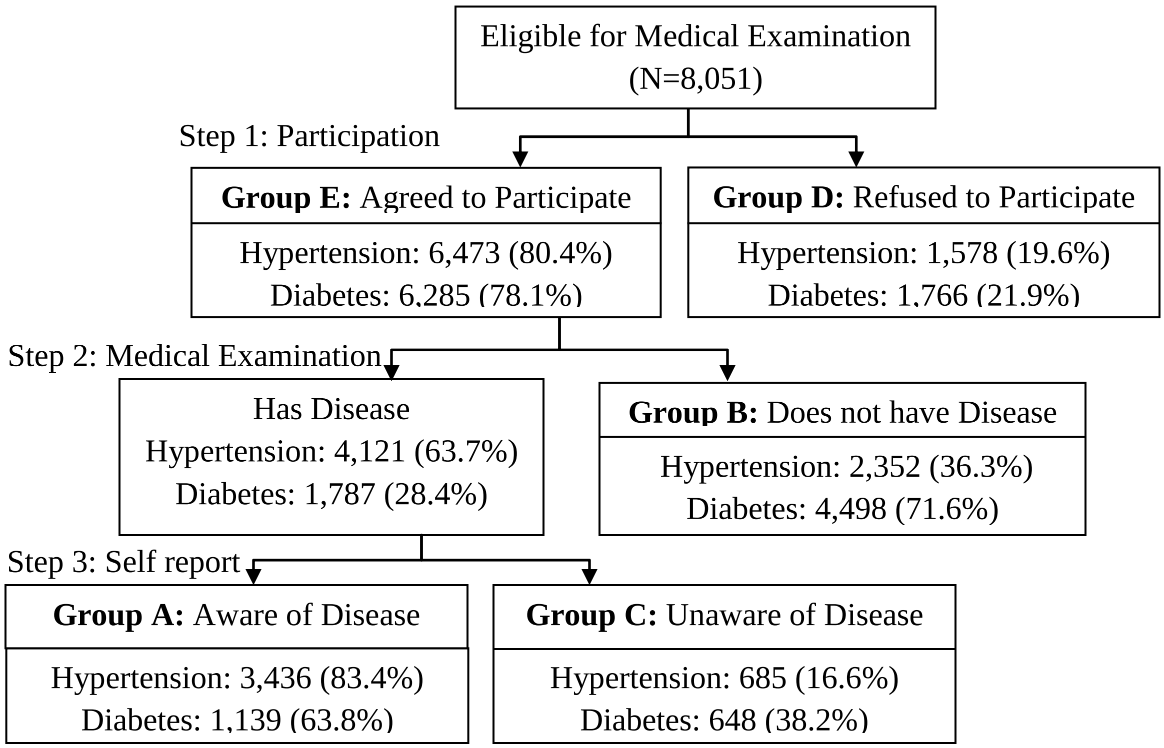

Figure 1b: Flow chart for an alternative model of chronic disease awareness, 2006 HRS

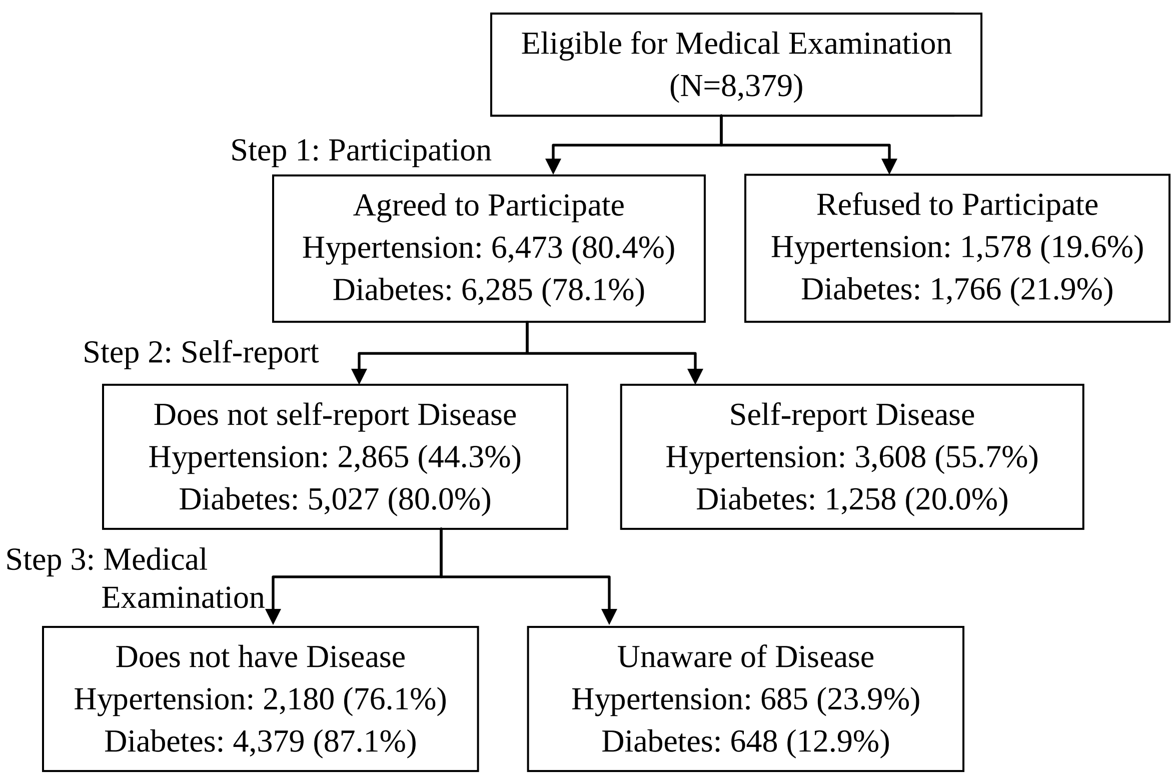

Table 1: Sample means (%, except income and age); N = 8,051

	(1) Total	Hypertension (2) Agreed	Hypertension (3) Refused	Hypertension (4) t-test	Diabetes (5) Agreed	Diabetes (6) Refused	Diabetes (7) t-test
Non-Latino white	75.7	76.3	73.3	**-2.48**	77.5	69.4	**-7.00**
African-American	13.8	13.0	17.1	**4.29**	12.2	19.5	**7.98**
Latino	8.2	8.5	7.0	**-1.94**	8.2	7.9	-0.43
Other race	2.3	2.3	2.6	0.77	2.1	3.1	**2.45**
Male	41.2	41.4	40.3	-0.83	40.7	43.1	**1.80**
Average Age	67.38	67.51	66.87	**-2.11**	67.12	68.32	**4.12**
High school dropout	22.0	21.2	25.2	**3.48**	21.1	25.3	**3.77**
High school graduate	33.8	33.8	33.5	-0.23	34.1	32.7	-1.11
Some college	22.1	22.4	20.9	-1.32	22.5	21.1	-1.24
College graduate or more	22.1	22.5	20.3	**-1.89**	22.4	21.0	-1.26
Married	64.2	65.6	58.5	**-5.30**	65.6	59.1	**-5.07**
Currently Employed	34.6	34.8	34.1	-0.51	36.1	29.6	**-5.09**
Household Income $	69,922	72,123	60,894	**-1.79**	72,913	59,276	**-2.27**
Self-report hypertension	56.4	55.7	58.9	**2.25**	55.8	58.5	**2.05**
Self-report diabetes	19.9	19.5	21.7	**1.98**	20.0	19.4	-0.55
Use cholesterol medication	39.0	39.6	36.6	**-2.16**	38.7	40.1	1.06
SAH=Excellent	11.5	12.1	8.9	**-3.64**	12.2	9.1	**-3.63**
SAH=Very Good	30.3	31.3	25.9	**-4.26**	31.3	26.4	**-3.96**
SAH=Good	30.7	30.7	30.8	0.07	30.8	30.4	-0.39
SAH=Fair	20.4	19.7	23.4	**3.30**	19.2	24.9	**5.21**
SAH=Poor	7.1	6.1	11.0	**6.86**	6.4	9.3	**4.12**
Overweight	33.5	34.4	29.5	**-3.75**	33.7	32.6	-0.85
Obese	28.2	26.8	33.7	**5.48**	28.4	27.1	-1.09
No BMI information	11.0	10.6	12.6	**2.35**	10.4	13.0	**3.07**
Private insurance only	29.9	29.9	30.0	0.08	30.5	27.9	**-2.05**
Medicare only	20.5	20.6	20.2	-0.36	19.6	23.7	**3.76**
Medicare & Private	32.3	32.9	29.7	**-2.43**	32.9	30.2	**-2.14**
Other insurance	16.1	15.4	19.0	**3.53**	15.9	16.7	0.80
Northeast	15.6	15.9	14.4	-1.44	14.8	18.6	**3.94**
Midwest	24.6	24.2	26.2	**1.66**	25.2	22.5	**-2.30**
South	38.5	38.8	37.4	0.72	38.4	38.9	-1.55
West	21.3	21.1	21.9	-1.00	21.6	19.9	0.40
Current smoker	14.0	11.6	24.3	**13.2**	13.6	14.7	0.92
Hostile	6.6	5.0	13.2	**11.9**	4.9	12.5	**11.32**
Uncooperative	3.1	1.7	9.2	**15.6**	1.5	9.1	**16.56**
Concerned about time	14.1	12.7	19.8	**7.3**	12.5	19.7	**7.69**

Table 2: Prevalence, awareness, and treatment of chronic diseases by race (%)

		Total	Non-Latino white	African-American	Latino	Other Race
Hypertension	**"Agreed to Participate" Sample (N=6,473)**					
	Self-Reported Hypertension	**55.7** [52.4] (0.0062)	**53.4** (0.0071)	**71.8**[10.0] (0.0156)	**54.4** [0.5] (0.0213)	**49.7**[-0.9] (0.0414)
	Objective Hypertension	**31.9** [30.8] (0.0058)	**30.5** (0.0066)	**40.2** [5.6] (0.0169)	**33.6** [1.5] (0.0202)	**26.5**[-1.0] (0.0365)
	Medication for Hypertension	**50.2** [46.7] (0.0062)	**48.1** (0.0071)	**65.4** [9.4] (0.0164)	**46.5**[-0.7] (0.0213)	**46.3**[-0.4] (0.0413)
	Objective or Medication	**63.7** [60.8] (0.0060)	**61.6** (0.0069)	**78.4** [9.5] (0.0142)	**61.1**[-0.2] (0.0208)	**57.8**[-0.9] (0.0409)
	"Has disease" (Objective measurement or Medication) Sample (N=4,121)					
	Awareness	**83.4** [81.7] (0.0058)	**82.5** (0.0069)	**87.8** [3.4] (0.0128)	**83.3** [0.4] (0.0204)	**82.3**[-0.0] (0.0416)
	Medication	**78.8** [76.9] (0.0064)	**78.0** (0.0075)	**83.4** [3.1] (0.0145)	**76.1** [-0.8] (0.0233)	**80.0** [0.4] (0.0436)
Diabetes	**"Agreed to Participate" Sample (N=6,285)**					
	Self-Reported Diabetes	**20.0** [18.2] (0.0050)	**17.4** (0.0054)	**28.8** [9.8] (0.0164)	**30.5** [8.1] (0.0202)	**24.8**[1.9] (0.0376)
	Objective measurement	**24.3** [22.3] (0.0054)	**20.4** (0.0058)	**37.3** [7.6] (0.0175)	**39.6** [9.6] (0.0215)	**32.3**[2.4] (0.0407)
	Medication for Diabetes	**16.5** [15.0] (0.0047)	**13.9** (0.0050)	**25.1**[10.6] (0.0157)	**27.4** [9.0] (0.0204)	**21.1**[2.2] (0.0355)
	Objective or Medication	**28.4** [26.0] (0.0057)	**24.4** (0.0061)	**42.7**[10.7] (0.0179)	**43.6** [9.6] (0.0218)	**36.8**[3.3] (0.0420)
	"Has disease" (Objective measurement or Medication) Sample (N=1,787)					
	Awareness	**63.7** [63.0] (0.0114)	**62.9** (0.0140)	**64.1** [0.4] (0.0266)	**67.3** [1.2] (0.0313)	**65.3**[0.3] (0.0687)
	Medication	**58.2** [57.8] (0.0117)	**57.2** (0.0144)	**58.9** [0.6] (0.0273)	**62.8** [1.6] (0.0322)	**57.1**[-0.0] (0.0714)

Notes: For total sample in the first column, weighted percentages are in square brackets. In the 3rd, 4th and 5th columns, t-test statistics are in square brackets. Baseline for the t-statistics is non-Latino white group. Standard errors are in parentheses.

Table 3a: Concordance Table for "Has Disease" and "Self-Reported Disease"

		Medical Examination - Disease	
		1: yes	0: no
Self-Reported Disease	1: yes	*a*	*b1*
	0: no	*c*	*b2*

Note: The sum of b1 and b2 equals b in the text.

Table 3b: Estimates of unawareness based on main and alternative definitions (%)

		Non-Latino whites	African-Americans	Latino	All
Main definition *c/(c+a)*	Hypertension	18	12	17	17
	Diabetes	37	36	33	36
Alternative Definition c/*(c+b2)*	Hypertension	23	34	22	24
	Diabetes	11	22	21	13

Note: See table 4 for the definitions of *a*, *b2* and *c*.

Table 4: Dependency tests between "has disease" and "self-reported disease" by race/ethnicity

		Pearson Contingency Test		Harding-Pagan Test		Benitez-Silva *et al*. Test	
		$\hat{I}$	t-statistics $H_0: \hat{I} = 1$ $H_1: \hat{I} \neq 1$	ρ	Wald test $H_0: \rho = 1$ $H_1: \rho \neq 1$	Coeff.	t test
Hyper-tension	Non-Latino white	0.8663 (0.0042)	**-27.60****	**0.7352**** (0.0087)	**928.22****	Reference	
	African American	0.8760 (0.0114)	**-10.89****	**0.7233**** (0.0275)	**101.08****	-0.0159 (0.0130)	-1.22
	Latino	0.8631 (0.0147)	**-9.31****	**0.7212**** (0.0275)	**102.92****	-0.0151 (0.0164)	-0.92
	Other Race	-	-	-	-	-0.0010 (0.0287)	-0.03
	Constant	-	-	-	-	**0.0826**** (0.0051)	16.30
	Total	0.8676 (0.0042)	**-31.43****	**0.7377**** (0.0077)	**1,170.8****	N=6,473	
Diabetes	Non-Latino white	0.8889 (0.0045)	**-24.66****	**0.6799**** (0.0162)	**392.57****	Reference	
	African-American	0.8324 (0.0135)	**-12.39****	**0.6962**** (0.0313)	**94.30****	**0.0691**** (0.0147)	4.70
	Latino	0.8456 (0.0159)	**-9.72****	**0.7369**** (0.0367)	**51.49****	**0.0617**** (0.0170)	3.64
	Other Race	-	-	-	-	0.0507 (0.0307)	1.65
	Constant	-	-	-	-	**0.0696**** (0.0047)	14.90
	Total	0.8780 (0.0041)	**-29.55****	**0.6905**** (0.0131)	**554.80****	N=6,285	

Notes: * P<0.05, ** P<0.01. Standard errors are in parentheses.

Table 5: Medical exam, prevalence, and awareness of hypertension: sequential model

	Panel 1 (N=8,051) Agreed to Participate		Panel 2 (N=6,473) Has Disease		Panel 3 (N=4,121) Aware of Disease	
African-American	-0.0545	[-0.0148]	**0.4122****	[0.1428]	0.1377	[0.0435]
	(0.0488)		(0.0585)		(0.0944)	
Latino	**0.1647****	[0.0413]	-0.0339	[-0.0158]	0.0085	[0.0020]
	(0.0679)		(0.0700)		(0.1026)	
Other Race	-0.0785	[-0.0217]	-0.0262	[-0.0082]	-0.0764	[-0.0204]
	(0.1090)		(0.1106)		(0.1631)	
Male	0.0272	[0.0072]	0.0371	[0.0132]	**-0.3387****	[-0.0768]
	(0.0351)		(0.0361)		(0.0525)	
Age	**0.3850***	[0.0998]	**0.8141****	[0.0828]	0.3763	[0.1334]
	(0.1728)		(0.2031)		(0.3201)	
Age squared	**-0.3886***	[-0.1008]	**-0.5622****	[-0.0858]	-0.4362	[-0.1351]
	(0.1675)		(0.1978)		(0.3002)	
Some college	0.0494	[0.0130]	-0.0826	[-0.0319]	**0.1383***	[0.0268]
	(0.0535)		(0.0559)		(0.0797)	
College or more	-0.0315	[-0.0085]	**-0.2054****	[-0.0771]	**0.1502***	[0.0228]
	(0.0563)		(0.0595)		(0.0829)	
Self-reported diabetes	**-0.0805***	[-0.0220]	**0.2817****	[0.1021]	**0.2661****	[0.0649]
	(0.0438)		(0.0489)		(0.0766)	
Uses cholesterol medication	**0.0624***	[0.0166]	**0.4032****	[0.1452]	**0.5278****	[0.1378]
	(0.0365)		(0.0374)		(0.0797)	
SAH=Very Good	-0.0541	[-0.0146]	**0.2285****	[0.0843]	**0.2282***	[0.0573]
	(0.0602)		(0.0567)		(0.0998)	
SAH=Good	**-0.1371***	[-0.0375]	**0.2495****	[0.0933]	**0.3909****	[0.0896]
	(0.0608)		(0.0590)		(0.1089)	
SAH=Fair	**-0.2060****	[-0.0580]	**0.2617****	[0.0977]	**0.5198****	[0.1047]
	(0.0668)		(0.0684)		(0.1206)	
SAH=Poor	**-0.4051****	[-0.1241]	**0.3122****	[0.1165]	**0.5809****	[0.0990]
	(0.0821)		(0.0979)		(0.1560)	
Obese	-	-	**0.5651****	[0.1958]	-	-
			(0.0483)			
Overweight			**0.2058****	[0.0753]		
			(0.0424)			
Hostile	**-0.3589****	[-0.1086]	-		-	
	(0.0653)					
Uncooperative	**-0.7833****	[-0.2668]				
	(0.0887)					
Concerned about time	**-0.2154****	[-0.0614]				
	(0.0456)					
ρ	ρ_{12}=0.1359 (0.1847)		ρ_{13}=-0.1686 (0.2972)		ρ_{23}= **-0.5010****(0.1938)	

Notes: *P<0.05, **P<0.01, standard errors in parentheses, marginal effects in square brackets. Coefficients on marital status, employment, insurance, region, smoking, and missing BMI not shown in table.

Table 6: Medical exam, prevalence, and awareness of diabetes: sequential model

	Panel 1(N=8,051) Agreed to Participate		Panel 2 (N=6,285) Has Disease		Panel 3 (N=1,787) Aware of Disease	
African-American	**-0.2718****	[-0.0843]	**0.4035****	[0.1263]	**-0.2793****	[-0.0399]
	(0.0479)		(0.0542)		(0.0946)	
Latino	-0.0065	[-0.0019]	**0.4755****	[0.1798]	**-0.1994***	[0.0034]
	(0.0645)		(0.0691)		(0.1088)	
Other Race	**-0.3012****	[-0.0963]	**0.5069****	[0.1679]	-0.2718	[-0.0181]
	(0.1015)		(0.1183)		(0.1896)	
Male	**-0.0883****	[-0.0256]	0.0594	[0.0137]	**0.1209***	[0.0673]
	(0.0338)		(0.0379)		(0.0677)	
Age	**0.3339***	[0.0933]	**0.9096****	[0.2079]	0.0349	[0.2246]
	(0.1734)		(0.2391)		(0.4435)	
Age squared	**-0.3891***	[-0.1087]	**-0.7536****	[-0.2214]	-0.1851	[-0.2481]
	(0.1675)		(0.2305)		(0.4239)	
Currently Employed	**0.1320****	[0.0374]	0.0086	[0.0127]	**-0.1734***	[-0.0791]
	(0.0453)		(0.0495)		(0.0860)	
Self-reported Hypertension	0.0218	[0.0063]	**0.1952****	[0.0679]	**0.1616***	[0.1168]
	(0.0350)		(0.0398)		(0.0797)	
Use cholesterol medication	-0.0096	[-0.0028]	**0.3864****	[0.1347]	**0.3077****	[0.2206]
	(0.0351)		(0.0397)		(0.0930)	
SAH=Very Good	-0.0544	[-0.0158]	**0.2660****	[0.0896]	0.1583	[0.1191]
	(0.0589)		(0.0721)		(0.1551)	
SAH=Good	**-0.1090***	[-0.0320]	**0.5134****	[0.1764]	**0.3217***	[0.2344]
	(0.0599)		(0.0728)		(0.1802)	
SAH=Fair	**-0.2272****	[-0.0689]	**0.6252****	[0.2157]	**0.4340***	[0.2840]
	(0.0651)		(0.0775)		(0.2003)	
SAH=Poor	**-0.2646****	[-0.0830]	**0.6745****	[0.2395]	**0.5246***	[0.2780]
	(0.0810)		(0.0956)		(0.2264)	
Log of Income	**0.0451***	[0.0126]	**-0.0876****	[0.0137]	-0.0008	[-0.0207]
	(0.0224)		(0.0259)		(0.0459)	
Obese	-		**0.6019****	[0.1507]	-	
			(0.0560)			
Overweight			**0.2383****	[0.0275]		
			(0.0471)			
Hostile	**-0.2959****	[-0.0937]	-		-	
	(0.0645)					
Uncooperative	**-0.8972****	[-0.3231]				
	(0.0883)					
Concerned about time	**-0.2575****	[-0.0796]				
	(0.0445)					
P	ρ_{12}=**-0.4708**** (0.1582)		ρ_{13}=0.2650 (0.2356)		ρ_{23}=**-0.6783**** (0.1160)	

Notes: See notes to Table 5.

Table 7: Racial/ethnic disparities in "Agreed to Participate", "Has Disease" and "Aware of Disease" outcomes under non-zero and zero error correlation assumption

Hypertension

	Non-zero correlation $\Omega \neq I$			Zero correlation $\Omega = I$		
	1st Step: Agreed to Participate	2nd Step: Has Disease	3rd Step: Aware of Disease	1st Step: Agreed to Participate	2nd Step: Has Disease	3rd Step: Aware of Disease
African-American	-0.0545 (0.0488)	**0.4122**** (0.0585)	0.1377 (0.0944)	-0.0531 (0.0488)	**0.4260**** (0.0576)	**0.2508**** (0.0838)
Latino	**0.1647**** (0.0679)	-0.0339 (0.0700)	0.0085 (0.1026)	**0.1649**** (0.0679)	-0.0415 (0.0683)	0.0190 (0.1056)
Other Race	-0.0785 (0.1090)	-0.0262 (0.1106)	-0.0764 (0.1631)	-0.0790 (0.1090)	-0.0273 (0.1110)	-0.1091 (0.1717)

Notes: *P<0.05, **P<0.01, Standard errors are in parentheses. Controls listed in Table 5.

Diabetes

	Non-zero correlation $\Omega \neq I$			Zero correlation $\Omega = I$		
	1st Step: Agreed to Participate	2nd Step: Has Disease	3rd Step: Aware of Disease	1st Step: Agreed to Participate	2nd Step: Has Disease	3rd Step: Aware of Disease
African-American	**-0.2718**** (0.0479)	**0.4035**** (0.0542)	**-0.2793**** (0.0946)	**-0.2748**** (0.0479)	**0.3649**** (0.0552)	-0.0819 (0.0961)
Latino	-0.0065 (0.0645)	**0.4755**** (0.0691)	**-0.1994*** (0.1088)	-0.0080 (0.0645)	**0.5026**** (0.0689)	0.0100 (0.1150)
Other Race	**-0.3012**** (0.1015)	**0.5069**** (0.1183)	-0.2718 (0.1896)	**-0.3039**** (0.1015)	**0.4688**** (0.1228)	-0.0994 (0.2072)

Notes: *P<0.05, **P<0.01, Standard errors are in parentheses. Controls listed in Table 6.

Table 8: Medical exam, self-report, and unawareness of hypertension: alternative model

	Agreed to Participate (1), N=8,051		Doesn't self-report Disease (2), N=6,473		Unaware of Disease (3), N=2,865	
African-American	-0.0279 (0.0493)	[-0.0075]	**-0.4212**** (0.0576)	[-0.1589]	**0.3672**** (0.0958)	[0.0809]
Latino	**0.1685**** (0.0682)	[0.0420]	0.0383 (0.0696)	[0.0171]	-0.0494 (0.1032)	[-0.0171]
Other Race	-0.0854 (0.1097)	[-0.0235]	0.0793 (0.1108)	[0.0303]	-0.0861 (0.1560)	[-0.0170]
Male	0.0274 (0.0353)	[0.0073]	**0.1558**** (0.0360)	[0.0618]	**0.2205**** (0.0686)	[0.0930]
Age	**0.4021*** (0.1734)	[0.1037]	**-0.7644**** (0.2002)	[0.1046]	**0.5757*** (0.2862)	[0.0899]
Age squared	**-0.4285*** (0.1682)	[-0.1105]	**0.5975**** (0.1945)	[-0.1126]	-0.3162 (0.2790)	[-0.0229]
Some college	0.0468 (0.0538)	[0.0123]	-0.0115 (0.0556)	[-0.0040]	**-0.1444*** (0.0836)	[-0.0501]
College or more	-0.0523 (0.0569)	[-0.0141]	**0.1037*** (0.0587)	[0.0404]	**-0.2971**** (0.0858)	[-0.0829]
Self-reported diabetes	-0.0362 (0.0447)	[-0.0097]	**-0.3846**** (0.0471)	[-0.1471]	0.1365 (0.1059)	[0.0013]
Use cholesterol medication	**0.0699*** (0.0367)	[0.0185]	**-0.5547**** (0.0367)	[-0.2126]	0.0311 (0.1169)	[-0.0562]
SAH=Very Good	-0.0289 (0.0606)	[-0.0077]	**-0.3390**** (0.0585)	[-0.1312]	-	-
SAH=Good	-0.0984 (0.0612)	[-0.0266]	**-0.4559**** (0.0607)	[-0.1748]		
SAH=Fair	**-0.1652**** (0.0669)	[-0.0458]	**-0.5361**** (0.0691)	[-0.2006]		
SAH=Poor	**-0.3592**** (0.0827)	[-0.1082]	**-0.6205**** (0.0953)	[-0.2220]		
Current Smoker	**-0.5100**** (0.0471)	[-0.1565]	**0.1502*** (0.0679)	[0.0525]	-0.0443 (0.0963)	[0.0211]
Obese	**-0.2772**** (0.0479)	[-0.0776]	**-0.4630**** (0.0537)	[-0.1798]	**0.4934**** (0.0916)	[0.1330]
Overweight	**-0.0825**** (0.0455)	[-0.0222]	**-0.2006**** (0.0439)	[-0.0794]	**0.1640**** (0.0658)	[0.0356]
Hostile	**-0.3622**** (0.0651)	[-0.1094]	-	-	-	-
Uncooperative	**-0.7876**** (0.0890)	[-0.2678]				
Concerned about time	**-0.2184**** (0.0457)	[-0.0621]				
P	ρ_{12}=-0.0787 (0.1922)		ρ_{13}=0.2846 (0.2769)		ρ_{23}=**-0.5194**** (0.1840)	

Notes: See notes to Table 5.

Table 9: Medical exam, self-report, and unawareness of diabetes: alternative model

	Agreed to Participate (1), N=8,051		Doesn't self-report Disease (2), N=6,285		Unaware of Disease (3), N=5,027	
African-American	**-0.2718**** (0.0482)	[-0.0864]	**-0.2033**** (0.0666)	[-0.0442]	**0.4513**** (0.0704)	[0.0980]
Latino	-0.0082 (0.0646)	[-0.0024]	**-0.3180**** (0.0747)	[-0.0865]	**0.4309**** (0.0965)	[0.1155]
Other Race	**-0.3011**** (0.1011)	[-0.0962]	**-0.3379**** (0.1344)	[-0.0838]	**0.4486**** (0.1480)	[0.1003]
Male	**-0.0880**** (0.0341)	[-0.0255]	**-0.1164**** (0.0429)	[-0.0260]	-0.0235 (0.0504)	[-0.0089]
Age	**0.3309*** (0.1737)	[0.0924]	**-0.9709**** (0.2585)	[0.1017]	**0.6471*** (0.2895)	[0.1647]
Age squared	**-0.3825*** (0.1680)	[-0.1068]	**0.9198**** (0.2776)	[-0.1142]	-0.4428 (0.2759)	[-0.1230]
Self-reported Hypertension	0.0142 (0.0351)	[0.0041]	**-0.3448**** (0.0457)	[-0.0815]	0.0600 (0.0580)	[0.0156]
Use cholesterol medication	-0.0128 (0.0351)	[-0.0037]	**-0.5449**** (0.0420)	[-0.1387]	0.0338 (0.0732)	[0.0103]
SAH=Very Good	-0.0387 (0.0591)	[-0.0112]	**-0.2751**** (0.0916)	[-0.0655]		
SAH=Good	-0.0860 (0.0602)	[-0.0251]	**-0.6258**** (0.0903)	[-0.1648]	-	-
SAH=Fair	**-0.2076**** (0.0654)	[-0.0627]	**-0.8242**** (0.0954)	[-0.2429]		
SAH=Poor	**-0.2524**** (0.0814)	[-0.0788]	**-0.9264**** (0.1122)	[-0.3008]		
No BMI Information	**-0.1191*** (0.0566)	[-0.0356]	**-0.2167**** (0.0757)	[-0.0531]	**0.1742*** (0.0822)	[0.0344]
Log of Income	**0.0456*** (0.0224)	[0.0127]	**0.0972**** (0.0293)	[0.0101]	**-0.0685*** (0.0365)	[-0.0132]
Obese	0.0518 (0.0455)	[0.0148]	**-0.6055**** (0.0608)	[-0.1660]	**0.3283**** (0.0910)	[0.0857]
Overweight	-0.0003 (0.0425)	[-0.0001]	**-0.2367**** (0.0562)	[-0.0591]	**0.1324**** (0.0632)	[0.0304]
Hostile	**-0.3032**** (0.0649)	[-0.0961]				
Uncooperative	**-0.8949**** (0.0882)	[-0.3221]	-	-	-	-
Concerned about time	**-0.2589**** (0.0445)	[-0.0800]				
ρ	ρ_{12}=0.2342 (0.1875)		ρ_{13}= **-0.5036**** (0.1631)		ρ_{23}=0.0304 (0.2192)	

Notes: See notes to Table 5.