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HEALTH DISPARITIES ACROSS EDUCATION:
THE ROLE OF DIFFERENTIAL REPORTING ERROR

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ABSTRACT

One of the most robust findings in health economics is that higher-educated individuals tend to be in better health. This paper tests whether health disparities across education are to some extent due to differences in reporting error across education. We test this hypothesis using data from the pooled National Health and Nutrition Examination Survey (NHANES) Continuous for 1999-2012, which include both self-reports and objective verification for an extensive set of health behaviors and conditions, including smoking, obesity, high blood pressure, high cholesterol and diabetes.

We find that better educated individuals report their health more accurately. This is true for a wide range of behaviors and conditions, even socially stigmatized ones like smoking and obesity. Differential reporting error across education leads to underestimates of the true health disparities across education that average 19.3%.

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1. Introduction

One of the most robust findings in health economics is that the better educated tend to be in better health (Grossman and Kaestner, 1997; Cutler and Lleras-Muney, 2010; Cutler, Huang & Llreas-Muney, 2015). This is true for many health behaviors and conditions, including smoking, drinking alcohol, obesity, exercise, and cancer screening (Cutler, Huang & Llreas-Muney, 2015; Grossman and Kaestner, 1997).

There are several possible mechanisms for this correlation. The model of health capital (Grossman, 1972) predicts that those with more schooling will demand more health. Education may increase allocative efficiency (the better educated may choose a healthier mix of inputs) and productive efficiency (the better educated may be able to produce more health with the same inputs). Cutler and Llreas-Muney (2010) conclude that knowledge and cognitive ability explain 30 percent, and health insurance, income, and family background account for another 30 percent, of the education gradient in health. This is consistent with earlier work that concluded that increased health knowledge explains part but not all of the relationship between education and smoking, alcohol consumption, and exercise (Kenkel, 1991).

This study tests a novel hypothesis for the correlation between education and self-reported health: differential reporting error by education.[1] One source of reporting error in health is social desirability bias, which is the result of respondents seeking to present a positive image to the interviewer (Edwards, 1957). As a result, the more stigmatized and negatively sanctioned the health condition or behavior, the stronger the tendency of respondents to deny it. The better educated may be more influenced by social desirability bias, because of greater awareness of medical

[1] Our focus in this paper is on self-reported health. Obviously, differential reporting error cannot explain educational differences in objectively measured health.

recommendations, public health messaging, or the health consequences of these conditions or behaviors. As a result, they may underreport risky health behaviors or stigmatized conditions.

On the other hand, there are reasons to believe that the better educated may report *more* accurately. They may be more knowledgeable about their health (perhaps because they have greater access to health care or independently monitor their health more closely) or are better able to comprehend and respond to survey questions. Thus, differential reporting error across education groups may lead to either an overestimate or an underestimate in educational gradients in health.

The direction and magnitude of such bias may differ by health condition and behavior. For example, people have detailed knowledge of their own smoking because it is a conscious act. Thus, reporting error in smoking may be less influenced by access to health care than the reporting of asymptomatic conditions such as high blood pressure or high cholesterol, which people may remain unaware of until they are tested and diagnosed by a medical professional. Also, conditions and behaviors differ in the extent to which they are socially stigmatized. It may be more embarrassing for a college graduate to report her weight or admit smoking than to report having high blood pressure. The extent of reporting error by education group may also differ by sex. For example, women tend to underreport their weight to a greater extent than men (e.g. Connor Gorber et al., 2007) but it is unclear whether differential reporting error by education varies by sex.

This paper relates to a large literature that measures, and documents the consequences of, reporting error in health. Some research focuses on the accuracy of reporting specific health conditions such as weight and arthritis. For example, Ljungvall, Gerdtham, and Lindblad (2015) find that women with higher education report their weight more accurately, and this differential reporting error leads to an underestimation of the educational disparity in obesity. The generalizability of this is questionable, as it is based on a sample of residents of two municipalities in southern Sweden. In contrast, Gil and Mora (2011) find that the self-report bias in BMI is roughly equal among those with the lowest educational attainment and those with a university degree. Again, this was for a local dataset, in this case of the Catalan population in Spain. Using data from southeastern Netherlands, Mackenbach et al. (1996) compared self-reports of lung disease, heart disease, and diabetes against information from the subjects' general practitioners and found that reporting error tends to bias downward estimates of the educational gradient in such conditions. Butler et al. (1987) found in the U.S. Survey of Disability and Work that those with a high school education (but not those with a college degree) were more likely than high school dropouts to accurately report having arthritis.

In contrast to the literature that examines responses regarding specific health conditions, other research has focused on other types of questions about health. Lindeboom and van Doorslaer (2004) examine responses to general questions about health to which respondent answers can range from "very poor" to "very good." Using data from the Canadian National Population Health Survey, they find no evidence that responses differ significantly by education. Bago d'Uva, O'Donnell, and van Doorslaer (2008) focus on how people of different levels of education differentially rate case vignettes that that describe levels of functioning within health domains. They examine six health domains (mobility, pain, sleep, breathing, emotional health and cognition) for older individuals in eight European countries. They find that in six countries the more highly educated individuals are generally more critical of a given health state (although in two countries the opposite is true) and that failure to correct for this differential reporting leads to underestimation of health inequalities by education. A related study (Bago d'Uva, van Doorslaer, Lindeboom, and O'Donnell, 2008) corrects self-reported health based on differential rating of hypothetical case vignettes and concludes that better educated people overreport their health in Indonesia and India, but underreport their health in China; as a result, correcting for reporting heterogeneity reduces the educational disparities in health in Indonesia and India but increases them in China. It should be noted that in all of these countries, the highest category of education is relatively low; the equivalent of high school graduate or better. Dowd and Todd (2011) conduct a similar study of differential responding by education to anchoring vignettes in the U.S. Health and Retirement Study.

Other research on reporting error in health has focused on the role of other aspects of socioeconomic status than education. Johnston, Propper, and Shields (2009) primarily examine income gradients in self-reported and measured hypertension in the Health Survey for England, but also find that the better educated are better informed about their health. Two subsequent studies built on this work. Suziedelyte and Johar (2013) estimate socioeconomic gradients in both self-reported and administratively documented major surgeries in New South Wales, Australia, and find that the gradients are unbiased by differential misreporting by education. Mosca et al. (2013) estimate socioeconomic gradients in hypertension and high cholesterol using data from Ireland; odds ratios for educational categories were not significantly different when one used self-reports as opposed to objectively measured health, in models that controlled for an extensive set of covariates.

This paper contributes to the literature in the following ways. It examines a wider range of health behaviors and conditions: smoking, high blood pressure, high cholesterol, diabetes, and obesity. It verifies subject responses using the results of lab tests, medical examinations, and measurements taken by medical professionals. It studies not only the accuracy of self-reports when compared to objective measures but also the direction of the reporting error to examine the possibility of social desirability bias in reporting some of the stigmatized behavior or conditions. It also examines the extent to which education is associated with refusal to take the medical exam, refusal to answer the survey questions, and answering that one doesn't know. It also examines the extent to which these educational differences in accuracy are explained by differential access to, and utilization of, health care. Finally, it calculates the magnitude of the bias in health disparities across education when using self-reports rather than objective measures; in other words, it examines how the use of self-reports biases estimates of educational disparities in health. This is done using a recent, large, nationally representative dataset for the U.S.

We find evidence of differential reporting error across education categories; specifically, those with a college degree are more likely to accurately report behaviors and conditions such as smoking, diabetes, and high blood pressure. We do not find evidence of social desirability bias among the better educated. In fact, the better educated are *less* likely to give false negative reports of stigmatized behaviors and conditions like smoking or obesity. Only a small percentage of this difference is explained by differential access to, and utilization of, health care. Our overall conclusion is that differential reporting error by education not only fails to explain the education gradient in health, it causes it to be underestimated.

2. Data: National Health and Nutrition Examination Survey (NHANES) 1999-2012

We examine the data from the National Health and Nutrition Examination Survey (NHANES) Continuous for 1999-2012. The NHANES is sponsored by the National Center for Health Statistics of the Centers for Disease Control and Prevention and surveys a nationally representative sample of the U.S. civilian non-institutionalized population that is selected using a complex, stratified, multistage probability cluster sampling design.[2] NHANES is well-suited for our research question because it is nationally representative and contains both self-reported measures and lab and examination results for an extensive set of health behaviors and conditions, including current smoking status, weight, high blood pressure, cholesterol, and diabetes.

Individuals answer questions about their health behaviors and conditions during the household component, and are tested and examined during a subsequent medical examination component, which takes place in mobile examination centers. 95.5% of the respondents to the

[2] For information on the NHANES sampling frame and data collection methods, see National Center for Health Statistics (2015).

household survey also participate in the examination component of the survey; hemophiliacs and those who received chemotherapy within the last 4 weeks are not included in the lab component.

Our sample is restricted to those who have completed both interview and examination components of NHANES and who are 25 years of age or older and are thus likely to have completed their schooling. We exclude respondents who have missing values for education and those whose home interviews were conducted with a proxy respondent. For regression models of obesity, we also exclude: 1) the 1999-2002 data because during those years the NHANES did not indicate whether the weight or height variables were reported by a proxy; and 2) those who, in any survey year, refused to change into an examination gown when measuring their weight or did not stand up straight or remove their shoes during the measurement of height.

Most questions about health behaviors and conditions are asked in the household interview; the exception is smoking status, which is asked at the mobile examination center. Individuals are asked whether they have ever been diagnosed with specific conditions; e.g. “Has a doctor or other health professional ever told you that you had (high blood pressure/diabetes/high cholesterol)?” (The full text of question wording is provided in Table 1.) For our purposes, the wording is not ideal because the person may have been diagnosed long ago and the condition resolved. However, we assume that the extent of any such changes does not differ by education.

Smoking status is verified by a urine test for serum cotinine. Cotinine is a metabolite of nicotine, has a half-life of approximately 20 hours, and can be detected for a few days after tobacco use. (The NHANES asks whether the individual used cigarettes or other nicotine products during the past 5 days, which matches the cotinine test much better than asking about smoking in the past 30 days or year.) The level of cotinine in the blood is proportional to the amount of exposure to tobacco smoke (Florescu et al., 2009). The medical literature does not agree on the appropriate cotinine threshold to define a smoker, so we use the two most common thresholds: 15ng/ml (Florescu et al., 2009) and 3ng/ml (Benowitz et al., 2009).

Weight is measured by health professionals using a calibrated scale after subjects change into paper examination gowns and remove their shoes. High blood pressure is measured by health professionals. Total cholesterol level is measured from blood specimens. LDL cholesterol level is also measured but only for those who are examined in the morning. Diabetes is assessed two ways: 1) blood glycohemoglobin level; and 2) fasting plasma glucose (FPG) levels. The FPG test is conducted only for those who participated in the morning examination sessions. Table 1 lists, for each health behavior and condition, the relevant NHANES survey question, the relevant NHANES examination or test, and any special restrictions on the sample stemming from the nature of the question or exam.

Based on the results of the medical examinations and tests, we classify individuals as having each condition based on the relevant clinical guidelines. The NIH defines high blood pressure as systolic of 140 or higher or diastolic of 90 or higher (CDC, 2015a). The NHANES survey question about high cholesterol does not distinguish whether the subject was diagnosed with high total cholesterol or high LDL cholesterol, so we examine each; the threshold for high total cholesterol is 240mg/dL and that for high LDL cholesterol is 160mg/dL (CDC, 2015b). Recall that there are two NHANES tests for diabetes: hemoglobin A1c (HbAIC) and fasting plasma glucose level. A diagnosis of diabetes is associated with HbA1c of 6.5 or greater or fasting plasma glucose of 126mg/dL or greater (CDC, 2015c). Obesity is defined as a body mass index (defined as weight in kilograms divided by height in meters squared) of 30 or higher (US DHHS, 2010).

One possible form of differential social desirability bias is that the better educated are more likely to perceive that the exam will check their self-reported answers, and they may wish to report more accurately to avoid being caught misreporting. This may lead reporting error to vary with education in the NHANES in a way that it would not in a survey that was conducted without an accompanying examination. However, the medical examination is not scheduled (and consent not sought) until the end of the home interview (Zipf, 2013), so in general respondents may not be thinking during their interview about a subsequent exam. In addition, the gap in time between the interview and exam (two weeks on average) means that there will be no instantaneous embarrassment from misreporting, and the guarantees of confidentiality of health data mean that the interviewer present for the household interview will not find out the exam results.

For several reasons, we ultimately decided not to report results for sexually transmitted infections (STI). First, the samples were smaller because only a subset of ages (14-49) were tested. Second, the correlations between self-reported and measured values were very low, presumably because STIs may have been contracted (and cured) long before the interview. In contrast, high blood pressure and high cholesterol tend to arise later in life and be more chronic conditions.

3. Empirical strategy

We test whether reporting error varies by education by estimating regression models of the following form:

$$Y_{it} = \alpha + \beta\ Education_{it} + \gamma\ X_{it} + \varepsilon_{it}$$

where Y_{it} is a measure of reporting error or accuracy for person i observed at time t. $Education_{it}$ is a vector of indicator variables for education category (less than high school, some college, and college graduate, with high school graduate as the excluded reference category). X_{it} is a vector of indicator variables for respondent characteristics: gender (we pool men and women because we fail to reject the equality of education coefficients across gender), race (non-Hispanic black, Hispanic, and other race, with non-Hispanic white is the omitted reference category), age, and year of interview. We also control for whether the respondent is a U.S. citizen and whether English is the primary language used at home because language and cultural background may affect comprehension of the survey questions. The NHANES records the age in months of the respondent at the interview screener and at the examination; we control for the difference between these two ages in our regression models as a means of controlling for the length of time between the self-report and the objective measurement.[3] However, age at exam is not provided in the 2011-12 NHANES data, so we must drop these years from the regression analysis (although these years are still used in the unconditional analyses). For models of smoking behavior, we also control for the presence of any smokers in the household, because the cotinine test reflects both own smoking and secondhand smoke. We exclude income from the model to allow for differences in income associated with education to be reflected in the correlation of education with the outcomes; we also re-estimated our models controlling for income and found very similar results.

We examine a series of dependent variables that measure the extent of reporting error. The first set measures accuracy regardless of the direction of any reporting error. These dependent variables equal 1 if the measured value matches the self-reported value for a specific health behavior or condition. One legitimate reason that a reported diagnosis might be paired with a negative test result is if the individual is taking medication for the condition; e.g. statins for high cholesterol. The NHANES contains information about prescribed medications, so for those who report being diagnosed with high blood pressure, cholesterol, or diabetes but test negative for it, we code them as accurately reporting the condition if they are currently taking medication for that condition.

The next set of dependent variables takes into account the direction of the error. The dependent variable for false negative reporting equals 1 if the respondent says he does not have the condition but the test result indicates that he does, and 0 otherwise. Conversely, the dependent

[3] The NHANES does not provide the exact dates of interview or the exam. In the authors' personal communication with the CDC administrators, we were told that the average gap between the interview and examination is 2 weeks (also see Zipf et al., 2013) and the average gap between the interview screener and the interview is 10 days.

variable for false positive reporting equals 1 if the respondent says she has the condition but the test result indicates that she does not, and 0 otherwise. Dependent variables for false negative and false positive reports are created for each health behavior and condition. The regressions for false negative reporting are particularly informative because they will indicate whether better educated people are over-reporting their health, and thus whether differential reporting error by education explains some of the education gradient in health.

Probit models are estimated, from which we report marginal effects. Regressions are weighted using the Centers for Disease Control and Prevention (CDC) recommended algorithm to construct multi-year survey weights (CDC, 2015d).

Clearly, education and health may affect each other; education may improve health, and individuals may invest in greater education when they perceive that they will be alive for additional periods for the education investment to pay off. However, the goal of this paper is not to estimate the causal effect of education on health[4], but to determine whether reporting error in health differs by education and whether that explains the educational gradient in health.

4. Results

The Educational Gradient in Self-Reported Health

Figure 1 displays the gradient of self-reported health over education in the NHANES, which follows the usual pattern: the better educated report better health. The prevalence of self-reported high blood pressure, high cholesterol, and diabetes decreases monotonically with education. For example, the prevalence of high blood pressure decreases from 39.0% among high school dropouts to 25.1% among college graduates. The prevalence of diabetes decreases from 17.3% among high school dropouts to 5.3% among college graduates.

[4] For recent estimates of the causal effect of education on health, see Clark and Royer (2013), McCrary and Royer (2011), de Walque (2007), and Lleras-Muney (2005).

Self-reported smoking and obesity (based on self-reported weight and height) are negatively correlated with education, but not monotonically. Smoking is actually less common among high school dropouts (25.2%) than among high school graduates (33.7%), but it is least common among college graduates (13.3%). Obesity has a similar prevalence among high school dropouts, high school graduates, and those with some college (all of which are in the range of 32.7% to 34.7%) but the prevalence of obesity is much lower among college graduates (22.8%). Figure 2 shows that these patterns are relatively similar by gender, with the exception that decreases in unhealthy behaviors and health conditions tend to be less monotonic across education categories for men than women.

Education and the Accuracy of Self-Reported Health

We first examine the accuracy of self-reported health in general, before turning to how that accuracy varies with education. Table 2 lists the unconditional correlations between the self-reported value and the measured value for each behavior and condition. The correlations tend to be high, ranging from .58 for high total cholesterol to over .83 for smoking. Table 3 presents descriptive statistics for the accuracy measures that are the dependent variables in the regression models. On average, most respondents accurately report their health; accuracy ranges from 80.3% for high total cholesterol to roughly 96% for both measures of diabetes. Except for high cholesterol, false negative reports are more common than false positive reports.

Figure 3 shows the accuracy of self-reported health by education group. For each measure of health, the likelihood that the self-report matches the objective test is higher for college graduates than for high school dropouts. In most cases, the accuracy rises monotonically with education category.

Table 4 presents marginal effects from probit regressions of the accuracy of self-reported health, regardless of direction of error. The dependent variable equals 1 if the self-report matches the test result and 0 if it does not. The results indicate that college graduates are significantly more likely to accurately report smoking (for both of the two cotinine thresholds), obesity, high blood pressure, and diabetes (by both tests). For example, the college-educated report smoking 1.4 to 1.7 percentage points (1.5% to 1.8%) more accurately (for the cotinine thresholds of 15 and 3 ng/ml respectively), obesity 1.3 percentage points (1.4%) more accurately, high blood pressure 1.6 percentage points (1.8%) more accurately, and diabetes 0.8 to 1.6 percentage points (0.8% to 1.7%) more accurately (based on the A1c and plasma glucose test respectively), than high school graduates.

There is some evidence of a correlation of education with accuracy at lower levels of educational attainment than college completion. Individuals with some college education are significantly more likely to accurately report smoking (both cotinine thresholds) than high school graduates.

Next we examine the association between education and the accuracy of reporting health, taking into consideration the direction of error. Table 5 presents marginal effects from probit models of false negative reporting (i.e. reporting that one does not have the condition when the test indicates that one does). False negatives are of particular interest because they may indicate social desirability bias. For every health behavior and condition listed in Table 5, the sign of the marginal effects are consistent with the college educated being less likely to provide false negative reports than high school graduates; in most cases these are statistically significant. College graduates are roughly 1.4 percentage points (33%) less likely to submit a false negative report of smoking, 1.2 percentage points (15.6%) less likely to submit a false negative report for high blood pressure, 1.2 percentage points (27.9%) less likely to submit a false negative report for high LDL cholesterol, and 0.7 percentage points (38.8%) and 1.3 percentage points (40.6%) less likely to submit a false negative report for diabetes (based on A1C and plasma glucose test respectively) than high school graduates.

Also, those with some college education are less likely to submit false negative reports for smoking (both cotinine thresholds), high cholesterol (based on LDL levels), and diabetes (based on plasma glucose levels) than high school graduates. An important conclusion from these models is that there is no evidence that the better educated are more likely to be influenced by social desirability bias. Even for smoking, which is relatively stigmatized, the better educated are less likely to provide false negative reports.

We next examine the correlates of false positive reporting – i.e. reporting that one has a condition when the test indicates that one does not. Table 6 lists the marginal effects from probit regressions for false positives. College graduates are less likely than high school graduates to submit false positive reports for obesity and diabetes (measured by plasma glucose). High school dropouts are more likely to provide false positive reports for obesity, but less likely to provide false positive reports for smoking compared to high school graduates. On the whole, education is less correlated with false positive reporting than it was with false negative reporting.

Implications for the Education Gradient in Health

We next explore how the differential reporting error by education influences perceptions of the educational gradient in health. There are several comparisons across educational category that could be made; we choose to compare those with a high school diploma or less to those with some college or more. In Table 7 and figure 4, we show the health discrepancy between these two education categories based on self-reports and objective measurement. For most health conditions and behaviors, the use of self-reports results in underestimates of the true (measured) health disparities across education. For example, the difference in smoking prevalence between the two education categories is 11.3 percentage points when calculated using self-reports, but is 12.9

percentage points when one uses cotinine tests (with a 15 ng/ml threshold) to determine smoking status. Thus, use of self-reports leads one to underestimate the extent to which the better educated are less likely to smoke by 1.6 percentage points or 12.4%. In some cases, use of self-reports leads to a very large understatement of health differences (e.g. 28% for diabetes, 25% for high blood pressure). In contrast, use of self-reports leads to overestimates of the educational disparities in high LDL and high total cholesterol; however, these raw reports have not been adjusted to account for the fact that some people who report having been diagnosed but test negative because they are taking medication for high cholesterol.[5] Use of self-reports does not bias the educational disparity in obesity prevalence. Across all behaviors and conditions that we examine, use of self-reports results in an underestimate of the true educational gradient in health by an average of 19.3%.

Extension 1: The Role of Health Care Utilization and Access

It is possible that some of the correlation of education with reporting accuracy is due to differential access to, and utilization of, health care. Specifically, better educated people may have greater access to health care, either because of higher income or because of greater information or a greater demand for health, and this increased access may result in them having better information about their conditions and being more likely to have been diagnosed with conditions, conditional on having them. In the literature on measurement of health disparities, this is known as diagnosis bias (see, e.g. Burgard and Chen, 2014). This is not relevant for smoking, for which no diagnosis from a doctor is needed, but may be very relevant for asymptomatic conditions such as high blood pressure or cholesterol. Subjects with greater health care utilization may even have better information about their weight, which can be measured at home but is routinely measured at doctor visits.

We investigate whether access to health care explains the correlation between education and self-report accuracy by re-estimating the models of the paper adding controls for health insurance

[5] Likewise, the reports for high blood pressure and diabetes have also not been adjusted to account for use of medications for those conditions.

coverage and type (private insurance, Medicare, Medicaid/SCHIP, with uninsured as the omitted reference category)[6] and the number of doctor visits[7] and an indicator variable for whether the respondent was hospitalized in the past year.

Table 8 presents the marginal effects from probit regressions of accuracy of self-reported health, regardless of the direction of error. The dependent variable equals 1 if the self-report matches the test result and 0 if it does not. The result follows the same pattern as in Table 4 but the point estimates tend to be slightly smaller. Even controlling for health care utilization and access, college educated individuals report their smoking status 1.3 percentage points (1.39%) and 1.5 percentage points (1.59%) more accurately (for the cotinine threshold of 15 and 3 ng/ml respectively), report obesity 1.1 percentage points (1.18%) more accurately, and report diabetes roughly 0.7 percentage points (0.72%) and 1.4 percentage points (1.47%) more accurately (based on A1C and plasma glucose test respectively) than high school graduates. On average, controlling for health care utilization and access reduces the marginal effect of being college graduate by one or two tenths of a percentage point, which is roughly one-sixth of the original marginal effect found in Table 4.

We also examine how controlling for utilization of health care affects estimates of the association of education with the direction of reporting error. Table 9 presents the marginal effects from probit models of false negative reporting and Table 10 presents the marginal effects from probit models of false positive reporting. In both cases, controlling for health care utilization and access has very little impact on the marginal effect of being a college graduate.

Extension 2: Role of Refusals and Don't Knows

[6] We also control for indicator variables for missing values of health insurance variables.

[7] The NHANES records categories, not the exact number, of doctor visits and inpatient stays. We control for a full set of indicator variables for categories of use, with 0 the omitted reference category.

Measurement error can also arise from subjects refusing to participate in the examination, refusing to answer the survey question or saying that they don't know. As an extension, we test whether the probability of participating in the examination and the probability of giving such responses varies with subject education.

Table 11 lists the percent of the sample that refused to answer each question or said they didn't know the answer. The main conclusion from the table is that very few respondents refuse to answer or say they don't know the answers to these health questions. For almost all questions the refusal rate is 0 to the second decimal point; the exception is weight (0.05% refusals). We estimate probit models of refusing to answer the weight question and find that education is not significantly correlated with the probability of refusal (see Table 12).

The percentages of respondents who say they don't know are greater than those for refusals, but still very small. The highest percentages saying they don't know are for weight (1.07%), height (1.63%) and high cholesterol (0.75%). Probit models for responding don't know, which are listed in Table 12, indicate that those with some college and college graduates are 0.3 percentage points (46.2%) less likely than high school graduates to say they don't know whether they were diagnosed with high cholesterol. In addition, high school dropouts are 0.3 percentage points (50%) more likely, and college graduates are 0.1 percentage points (16.7%) less likely, to say they don't know their weight, relative to high school graduates.

A very high percentage (95.5%) of the NHANES respondents participate in both interview and examination parts of the survey, but it is possible that better educated individuals are more likely to refuse to complete the examination due to social desirability bias or a higher opportunity cost of time. To test this, we estimate probit models of refusing to complete the examination as a function of education and other regressors as in the earlier model. Table 12 shows that college graduates are 0.9 percentage points (17.3%) more likely than high school graduates to refuse the examination.

5. Conclusion

This paper tests a novel hypothesis for the widely-recognized and heavily-studied positive correlation between education and health: differential reporting error by education. We hypothesized that the better educated may be less likely to report socially stigmatized health behaviors like smoking and excess weight, with the consequence of exaggerating true differences in health across education categories. A wide variety of tests yields no evidence of this. In fact, we find strong evidence that the better educated report more accurately. This is true for a wide variety of health behaviors and conditions, such as smoking, high blood pressure, diabetes, and obesity. The correlation is found for both conscious acts (smoking), characteristics that are easily measured at home (weight) and asymptomatic conditions that would need to be diagnosed by a doctor (high blood pressure, high cholesterol).

The more accurate reporting of the better educated is only partly explained by increased access to, and utilization of, health care. Our results are robust to controlling for health insurance coverage and type, as well as number of doctor visits and hospitalization in the past year; adding such controls only explains, on average, one-sixth of the association of college graduation with self-report accuracy.

We find strong evidence that college graduates report their health with greater accuracy, and also evidence that those with only some college report more accurately, relative to those who are high school graduates and have no further education. There is weaker evidence that high school dropouts report less accurately than high school graduates.

Higher education is associated with a lower probability of false negative reporting, but is not generally correlated with the probability of false positive reporting. In other words, the increased accuracy is concentrated among the better educated who smoke and have these medical conditions.

This paper improves our understanding of one of the most robust findings in health economics – the positive correlation between education and health. Our results imply that the educational gradient in health, when measured using self-reported health, tends to understate the true gradient. A direction for future research is to estimate the causal relationship between education and differential reporting error of health behaviors and conditions; that is, does increasing education have the causal effect of increasing one's accuracy in reporting health or answering surveys generally?

Although we find no evidence of greater social desirability bias among the better-educated, all we can conclude is that the college educated report more accurately overall. It is possible that the better educated do experience greater social desirability bias, but this is outweighed by their increased health knowledge or comprehension of survey questions. All we observe is the net of these various possible influences.

This study underscores the importance of collecting and using objective measures of health behaviors and conditions in surveys. Research that estimates the causal effect of education on health may result in biased estimates if it relies on self-reported measures of health. For example, deWalque (2007), using risk of induction into the U.S. military during the Vietnam War as an instrument, finds that one year of college education reduces self-reported smoking by 4 percentage points. Our findings suggest that, because that result was based on self-reported smoking, it may understate the true health benefits of education.

To clarify, the problem lies not with researchers - when both measurements and self-reports are available, researchers tend to use the measurements – but with datasets, which frequently include only self-reports. Data producers should carefully consider the cost-effectiveness of including measurements of health and objective verification of health behaviors and conditions in their datasets.

Data producers can also take steps to maximize the accuracy of responses to interview questions on health. This could take the form of selecting the mode of survey to encourage more accurate reporting (see, e.g., Brener et al., 2003) or offering rewards for accurate reporting for a subset of the sample that has their answers verified (see, e.g., Philipson, 1997, 2001). Such strategies may reduce the average reporting error, even if not the educational differences in it.

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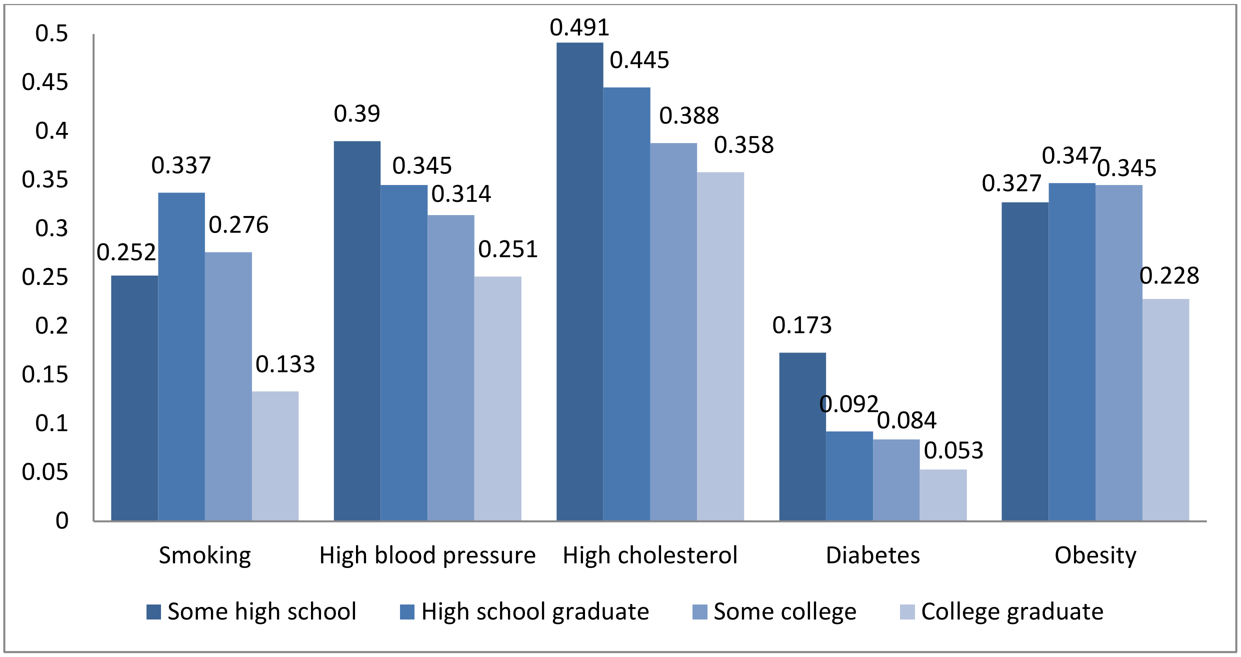
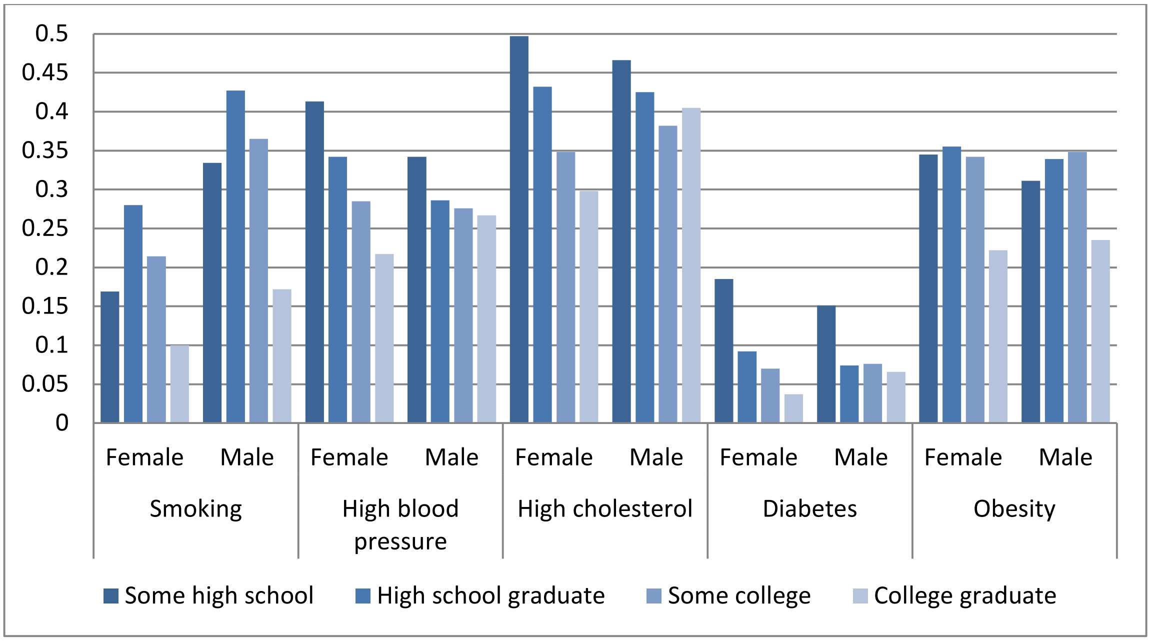
Figure 1. Prevalence of Self-Reported Health Behaviors and Conditions by Education



Data: pooled Continuous NHANES 1999-2012 data

Note: Sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

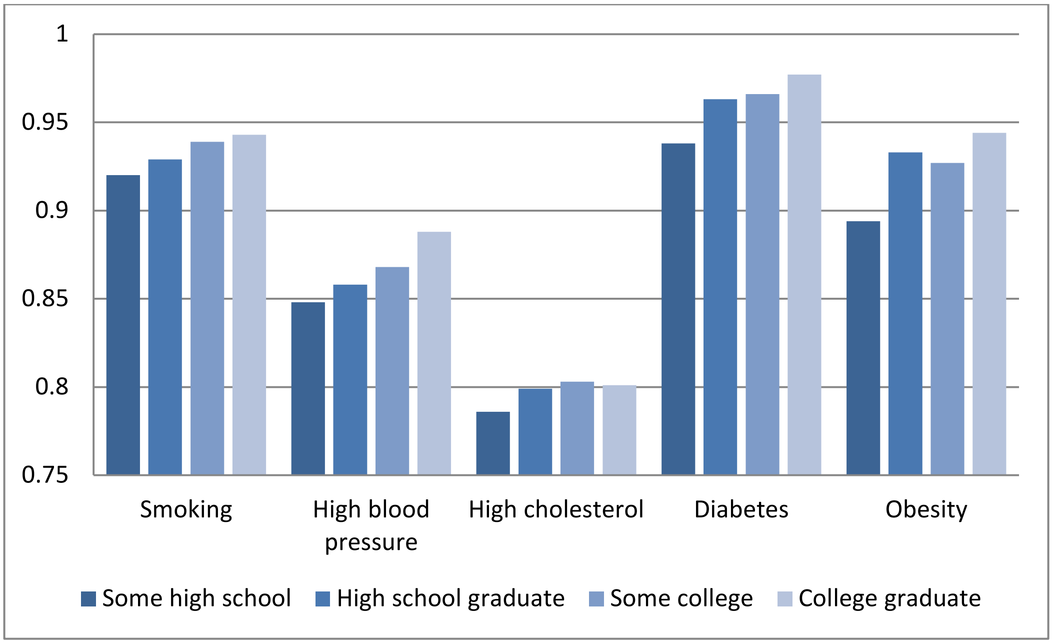
Figure 2. Prevalence of Self-Reported Health Behaviors and Conditions by Education and Gender



Data: pooled Continuous NHANES 1999-2012 data

Note: Sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who are pregnant, who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

Figure 3. Accuracy (%) of Self-Reported Health Behaviors and Conditions by Education

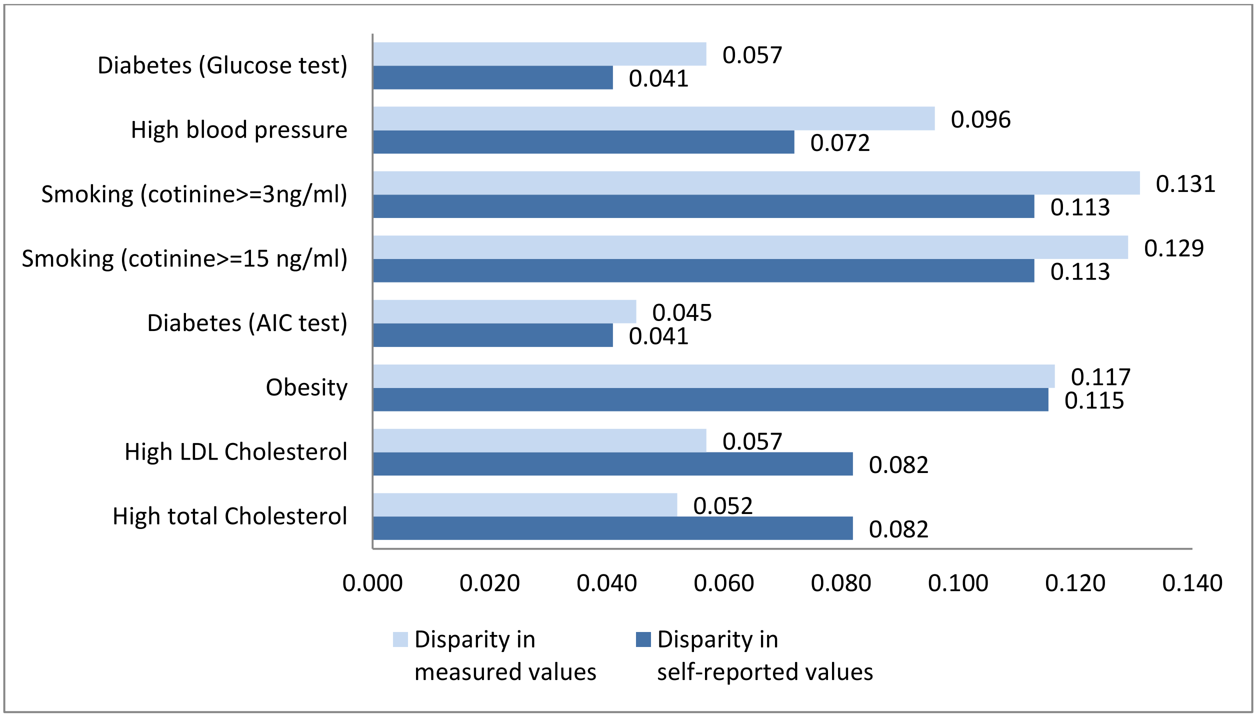


Data: continuous NHANES 1999-2012 (pooled).

Note: Sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who are pregnant, who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

Figure 4. Health Disparities across Education Groups

(comparing high school graduate or less vs. some college or college graduates)



Data: continuous NHANES 1999-2012 (pooled).

Note: Sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who are pregnant, who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

Table 1. Information on Self-Reported and Objectively Measured Health Data

Health Behavior/Condition	Survey Question	Objective Tests	Notes (eligible sample, exclusion criteria etc.)
Smoking	During the past 5 days, did [respondent] use any product containing nicotine including cigarettes, pipes, cigars, chewing tobacco, snuff, nicotine patches, nicotine gum, or any other product containing nicotine?	Measured by serum cotinine levels in urine tests. We examine two cotinine cutoffs to define smoking status: 15ng/ml, 3 ng/ml respectively	Question on recent tobacco use asked at the mobile examination center where various lab tests and examinations are conducted
Weight and height	How much do you weigh without clothes or shoes (lbs)? How tall are you without shoes (inches)?	Measured by health professionals using calibrated scale, tape measure	We examine waves after 2001 because earlier waves did not indicate whether proxies responded to the questionnaires We exclude respondents who were flagged for not standing up straight, removing their shoes, or changing into examination gown during measurements
High blood pressure	Have you ever been told by a doctor or other health professional that you had high blood pressure?	Measured by health professionals. After the participant rests quietly in a sitting position for 5 minutes, three consecutive blood pressure readings are obtained (4^{th} measurement is obtained if a blood pressure measurement is interrupted or not complete). Averaged 4 measurements of systolic and diastolic pressures.	Exclusion criteria**:** presence of the following on both arms: rashes, gauze dressings, casts, edema, paralysis, tubes, open sores or wounds, withered arms, a-v shunts, or if blood has been drawn from arm within the last week.

Table 1. Information on Self-Reported and Objectively Measured Health Data

Health Behavior/Condition	Survey Question	Objective Tests	Notes (eligible sample, exclusion criteria etc.)
LDL cholesterol	Have you ever been told by a doctor or other health professional that your blood cholesterol was high?	Measured with blood test: High LDL ("bad") cholesterol defined as 160 mg/dL or higher	Test conducted only for those with morning examination times
Total cholesterol	Have you ever been told by a doctor or other health professional that your blood cholesterol was high?	Measured with blood test: High total cholesterol defined as 240 mg/dL or higher	
Diabetes (glycohemoglobin test)	Other than during pregnancy, have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?	Measured with blood test. Diabetes defined as glycohemoglobin (AIC %) of 6.5 or greater	
Diabetes (plasma glucose test)	Other than during pregnancy, have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?	Measured with blood test. Diabetes defined as plasma glucose level of 126mg/dL or greater	Test conducted only for those with morning examination times

Source: Centers for Disease Control and Prevention (CDC). National Center for Health Statistics (NCHS). National Health and Nutrition Examination Survey Questionnaire (or Examination Protocol, or Laboratory Protocol). Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2015. http://www.cdc.gov/nchs/data/nhanes/pe.pdf Accessed June 3, 2015.

Table 2. Unweighted Correlation Between Self-Reported and Objective Measures

Health Behavior or Condition	Correlation Between Self-Report and Measurement
Smoking (test : cotinine >=15ng/ml)	0.833
Smoking (test : cotinine >=3ng/ml)	0.852
Obesity	0.848
High blood pressure	0.70
High LDL cholesterol	0.592
Total cholesterol	0.577
Diabetes (A1C test)	0.783
Diabetes (Glucose test)	0.747

Data: continuous NHANES 1999-2012 (pooled).
Note: Sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who are pregnant, who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

Table 3. Descriptive Statistics

Accurate reporting of:	**Mean**	**SD**	**N**
Smoking (cotinine >=15ng/ml)	0.935	0.25	21144
Smoking (cotinine >=3ng/ml)	0.941	0.24	21144
Obesity	0.932	0.25	13822
High blood pressure	0.868	0.34	21860
High cholesterol (LDL cholesterol)	0.807	0.39	7513
High cholesterol (total cholesterol)	0.803	0.4	16140
Diabetes (A1c)	0.966	0.18	21576
Diabetes (plasma glucose)	0.955	0.21	10539
False negative reporting of:			
Smoking (cotinine >=15ng/ml)	0.042	0.2	21144
Smoking (cotinine >=3ng/ml)	0.048	0.21	21144
Obesity	0.052	0.22	13822
High blood pressure	0.077	0.27	21860
High cholesterol (LDL cholesterol)	0.043	0.2	7513
High cholesterol (total cholesterol)	0.062	0.24	16140
Diabetes (A1c)	0.018	0.13	21576
Diabetes (plasma glucose)	0.032	0.17	10539
False positive reporting of:			
Smoking (cotinine >=15ng/ml)	0.023	0.15	21144
Smoking (cotinine >=3ng/ml)	0.011	0.11	21144
Obesity	0.016	0.22	13822
High blood pressure	0.056	0.23	21860
High cholesterol (LDL cholesterol)	0.151	0.36	7513
High cholesterol (total cholesterol)	0.135	0.34	16140
Diabetes (A1c)	0.016	0.13	21576

Diabetes (plasma glucose)	0.014	0.12	10539

Data: continuous NHANES 1999-2010 (pooled) Note: Sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who are pregnant, who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

Table 4. Probit Models of Accurate Reporting

	Smoking		*Obesity*	*High Blood Pressure*	*High Cholesterol*		*Diabetes*	
VARIABLES	**Cotinine >=15ng/ml**	**Cotinine >=3ng/ml**			**High LDL**	**Total Cholesterol**	**A1C test**	**Plasma glucose**
Mean of Dep Var	0.935	0.941	0.932	0.868	0.807	0.803	0.966	0.955
Less than high school	0.007	-0.001	-0.015	-0.007	0.015	-0.026	-0.003	0.002
	(0.007)	(0.007)	(0.009)	(0.011)	(0.021)	(0.017)	(0.004)	(0.006)
Some college	**0.011****	**0.011****	-0.003	0.002	0.017	0.007	-0.001	0.007
	(0.005)	**(0.005)**	(0.006)	(0.008)	(0.013)	(0.009)	(0.002)	(0.005)
College graduate	**0.014*****	**0.017*****	**0.013****	**0.016****	0.016	0.016	**0.008*****	**0.016*****
	(0.005)	**(0.005)**	**(0.006)**	**(0.007)**	(0.016)	(0.011)	**(0.003)**	**(0.005)**
Observations	19974	19974	13261	20801	7098	15277	20099	9827

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.10. [Data:Continuous NHANES 1999-2010 (pooled)]

Notes: All regressions control for indicator variables for survey year, gender, age, race/ethnicity, citizenship status, whether English is the primary language spoken at home, and education categories (omitted category: high school graduate, other race), and the difference between age in months at screening and at examination. For smoking regressions, we control for whether anyone in the household smokes to account for second hand smoking. Cotinine cutoff for smoking status: 15ng/ml, 3 ng/ml respectively

This table reports marginal effects from probit models. Regression sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

Table 5. Probit Models of False Negative Reporting

	Smoking		*Obesity*	*High Blood Pressure*	*High Cholesterol*		*Diabetes*	
VARIABLES	**Cotinine >=15ng/ml**	**Cotinine >=3ng/ml**			**High LDL**	**Total Cholesterol**	**A1C test**	**Plasma glucose**
Mean of Dep Var	0.042	0.048	0.052	0.077	0.043	0.062	0.018	0.032
Less than high school	0.000	0.007	0.001	-0.000	-0.008	0.003	0.001	-0.002
	(0.006)	(0.007)	(0.007)	(0.007)	(0.009)	(0.010)	(0.002)	(0.005)
Some college	**-0.011*** **	**-0.010** **	0.002	-0.005	**-0.013** **	-0.003	-0.000	**-0.007* **
	(0.004)	**(0.004)**	(0.005)	(0.005)	**(0.006)**	(0.006)	(0.002)	**(0.004)**
College graduate	**-0.014*** **	**-0.014*** **	-0.007	**-0.012** **	**-0.012* **	-0.006	**-0.007*** **	**-0.013*** **
	(0.004)	**(0.004)**	(0.005)	**(0.005)**	**(0.006)**	(0.006)	**(0.002)**	**(0.004)**
Observations	19974	19974	13253	20801	7038	15277	20099	9017

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.10. [Data: Continuous NHANES 1999-2010 (pooled)]

Notes: All regressions control for indicator variables for survey year, gender, age, race/ethnicity, citizenship status, whether English is the primary language spoken at home, and education categories (omitted category: high school graduate, other race), and the difference between age in months at screening and at examination. For smoking regressions, we control for whether anyone in the household smokes to account for second hand smoking. Cotinine cutoff for smoking status: 15ng/ml, 3 ng/ml respectively

This table reports marginal effects from probit models. Regression sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

Table 6. Probit Models of False Positive Reporting

	Smoking		*Obesity*	*High Blood Pressure*	*High Cholesterol*		*Diabetes*	
VARIABLES	**Cotinine >=15ng/ml**	**Cotinine >=3ng/ml**			**High LDL**	**Total Cholesterol**	**A1C test**	**Plasma glucose**
Mean of Dep Var	0.023	0.011	0.016	0.056	0.151	0.135	0.016	0.014
Less than high school	**-0.007****	**-0.006*****	**0.014*****	0.005	-0.004	0.023	0.002	0.000
	(0.003)	**(0.002)**	**(0.005)**	(0.008)	(0.021)	(0.015)	(0.002)	(0.003)
Some college	0.001	-0.001	0.000	0.003	-0.001	-0.004	0.002	-0.000
	(0.003)	(0.002)	(0.002)	(0.006)	(0.011)	(0.009)	(0.002)	(0.002)
College graduate	0.001	-0.002	**-0.006****	-0.003	-0.002	-0.011	-0.001	**-0.004***
	(0.003)	(0.002)	**(0.002)**	(0.005)	(0.014)	(0.010)	(0.002)	**(0.002)**
Observations	18,916	17,670	12,415	20,801	7,098	15,277	18,871	8,885

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.10. [Data:Continuous NHANES 1999-2010 (pooled)]

Notes: All regressions control for indicator variables for survey year, gender, age, race/ethnicity, citizenship status, whether English is the primary language spoken at home, and education categories (omitted category: high school graduate, other race), and the difference between age in months at screening and at examination. For smoking regressions, we control for whether anyone in the household smokes to account for second hand smoking. Cotinine cutoff for smoking status: 15ng/ml, 3 ng/ml respectively

This table reports marginal effects from probit models. Regression sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

Table 7. Health Disparities Across Education: (High School Graduate or Less) vs. (Some College or More)

Health Conditions/Behaviors	*Disparity in self-reported values*	*Disparity in measured values*	*% point difference*	*% difference*
High total Cholesterol	0.082	0.052	0.030	57.692
High LDL Cholesterol	0.082	0.057	0.025	43.860
Obesity	0.115	0.117	-0.001	-0.944
Diabetes (AIC test)	0.041	0.045	-0.004	-8.889
Smoking (cotinine>=15 ng/ml)	0.113	0.129	-0.016	-12.403
Smoking (cotinine>=3ng/ml)	0.113	0.131	-0.018	-13.740
High blood pressure	0.072	0.096	-0.024	-25.000
Diabetes (Glucose test)	0.041	0.057	-0.016	-28.070
Average				-19.256

Data: continuous NHANES 1999-2012 (pooled)

Note: Sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

Reports and measures of high cholesterol, high blood pressure, and diabetes are not adjusted to account for fact that some individuals are taking medications for those conditions (the accuracy measures that serve as dependent variables in the regression models do take medication use into account).

Table 8. Probit Models of Accurate Reporting

(controlling for health insurance, any doctor's visit, any hospitalization last year)

	Smoking		*Obesity*	*High blood pressure*	*High Cholesterol*		*Diabetes*	
VARIABLES	**Cotinine >=15ng/ml**	**Cotinine >=3ng/ml**			**High LDL**	**Total Cholesterol**	**A1C test**	**Plasma glucose**
Mean of Dep Var	0.935	0.941	0.932	0.868	0.807	0.803	0.966	0.955
Less than high school	0.010	0.003	-0.012	-0.001	0.014	-0.023	-0.002	0.003
	(0.006)	(0.007)	(0.009)	(0.011)	(0.022)	(0.017)	(0.004)	(0.005)
Some college	**0.010****	**0.010****	-0.004	-0.001	0.018	0.006	-0.001	0.007
	(0.005)	**(0.005)**	(0.006)	(0.008)	(0.013)	(0.010)	(0.002)	(0.005)
College graduate	**0.013****	**0.015*****	**0.011***	0.010	0.017	0.014	**0.007*****	**0.014*****
	(0.005)	**(0.005)**	**(0.006)**	(0.007)	(0.016)	(0.011)	**(0.003)**	**(0.005)**
Observations	19,957	19,957	13,253	20,783	7,093	15,269	20,083	9,818

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.10. [Data:Continuous NHANES 1999-2010 (pooled)]

Notes: All regressions control for indicator variables for survey year, gender, age, race/ethnicity, citizenship status, whether English is the primary language spoken at home, and education categories (omitted category: high school graduate, other race), and the difference between age in months at screening and at examination. For smoking regressions, we control for whether anyone in the household smokes to account for second hand smoking. Cotinine cutoff for smoking status: 15ng/ml, 3 ng/ml respectively

This table reports marginal effects from probit models. Regression sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

Table 9. Probit Models of False Negative Reporting

(controlling for health insurance, any doctor's visit, any hospitalization last year)

	Smoking		***Obesity***	***High Blood Pressure***	***High Cholesterol***		***Diabetes***	
VARIABLES	**Cotinine >=15ng/ml**	**Cotinine >=3ng/ml**			**High LDL**	**Total Cholesterol**	**A1C test**	**Plasma glucose**
Mean of Dep Var	0.042	0.048	0.052	0.077	0.043	0.062	0.018	0.032
Less than high school	-0.002	0.003	-0.001	-0.002	-0.008	0.001	0.001	-0.003
	(0.005)	(0.006)	(0.007)	(0.007)	(0.009)	(0.010)	(0.002)	(0.005)
Some college	**-0.011*****	**-0.010****	0.003	-0.003	**-0.013****	-0.002	-0.000	**-0.007***
	(0.004)	**(0.004)**	(0.005)	(0.005)	**(0.006)**	(0.006)	(0.002)	**(0.004)**
College graduate	**-0.013*****	**-0.013*****	-0.006	**-0.009***	**-0.011***	-0.004	**-0.006*****	**-0.012*****
	(0.004)	**(0.004)**	(0.005)	**(0.005)**	**(0.006)**	(0.006)	**(0.002)**	**(0.004)**
Observations	19,957	19,957	13,245	20,783	7,033	15,269	20,083	9,008

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.10. [Data:Continuous NHANES 1999-2010 (pooled)]

Notes: All regressions control for indicator variables for survey year, gender, age, race/ethnicity, citizenship status, whether English is the primary language spoken at home, and education categories (omitted category: high school graduate, other race), and the difference between age in months at screening and at examination. For smoking regressions, we control for whether anyone in the household smokes to account for second hand smoking. Cotinine cutoff for smoking status: 15ng/ml, 3 ng/ml respectively

This table reports marginal effects from probit models. Regression sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

Table 10. Probit Models of False Positive Reporting

(controlling for health insurance, any doctor's visit, any hospitalization last year)

	Smoking		***Obesity***	***High Blood Pressure***	***High Cholesterol***		***Diabetes***	
VARIABLES	**Cotinine >=15ng/ml**	**Cotinine >=3ng/ml**			**High LDL**	**Total Cholesterol**	**A1C test**	**Plasma glucose**
Mean of Dep Var	0.023	0.011	0.016	0.056	0.151	0.135	0.016	0.014
Less than high school	**-0.007****	**-0.006*****	**0.012*****	0.001	-0.003	0.023	0.000	-0.001
	(0.003)	**(0.002)**	**(0.004)**	(0.007)	(0.022)	(0.015)	(0.002)	(0.002)
Some college	0.002	-0.000	0.000	0.004	-0.002	-0.004	0.001	-0.000
	(0.003)	(0.002)	(0.002)	(0.006)	(0.011)	(0.009)	(0.002)	(0.002)
College graduate	0.002	-0.002	**-0.005***	-0.001	-0.002	-0.011	-0.001	-0.003
	(0.003)	(0.002)	**(0.002)**	(0.006)	(0.014)	(0.010)	(0.002)	(0.002)
Observations	18,901	17,659	12,408	20,783	7,093	15,269	18,856	8,878

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.10. [Data:Continuous NHANES 1999-2010 (pooled)]

Notes: All regressions control for indicator variables for survey year, gender, age, race/ethnicity, citizenship status, whether English is the primary language spoken at home, and education categories (omitted category: high school graduate, other race), and the difference between age in months at screening and at examination. For smoking regressions, we control for whether anyone in the household smokes to account for second hand smoking. Cotinine cutoff for smoking status: 15ng/ml, 3 ng/ml respectively

This table reports marginal effects from probit models. Regression sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

Table 11. Percent of respondents who refused to answer or reported "don't know"

Health Conditions / Behaviors	*% Refused*	*% Don't know*	*Refusals (N)*	*Don't know (N)*	*Total sample size*
Smoking	0	0	0	0	21114
High blood pressure	0	0.15	0	34	23019
High Cholesterol	0	0.75	1	129	17183
Diabetes	0	0.07	0	14	23809
Weight	0.0005	1.069	13	245	22963
Height	0.00004	1.63	1	374	22915

Data: continuous NHANES 1999-2010 (pooled)

Note: Sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height.

Table 12. Probit Models for Refusing, Saying Didn't Know

Variables	*Refused entire examination*		*Refused to report weight*		*Don't know (weight)*		*Don't know (high cholesterol)*	
Mean of Dep Var	0.052		0.0005		0.006		0.0065	
Less than high school	0.008	0.007	**-0.001***	-0.001	**0.003****	**0.002****	0.002	0.002
	(0.006)	(0.006)	**(0.000)**	(0.000)	**(0.001)**	**(0.001)**	(0.003)	(0.003)
Some college	0.002	0.002	0.000	0.000	-0.000	-0.000	**-0.003****	**-0.003****
	(0.004)	(0.004)	(0.001)	(0.001)	(0.001)	(0.001)	**(0.001)**	**(0.001)**
College graduate	**0.009****	**0.010****	-0.000	-0.000	**-0.001****	**-0.001***	**-0.003***	-0.002
	(0.005)	**(0.004)**	(0.000)	(0.000)	**(0.001)**	**(0.001)**	**(0.002)**	(0.002)
Control for health insurance and health care utilization	N	Y	N	Y	N	Y	N	Y
Observations	24,357	24,328	21,770	21,753	21,713	21,695	12,245	12,240

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.10. [Data:Continuous NHANES 1999-2010 (pooled)]

Notes: All regressions control for indicator variables for survey year, gender, age, race/ethnicity, citizenship status, whether English is the primary language spoken at home, and education categories (omitted category: high school graduate, other race), and the difference between age in months at screening and at examination. For smoking regressions, we control for whether anyone in the household smokes to account for second hand smoking. Cotinine cutoff for smoking status: 15ng/ml, 3 ng/ml respectively

Sample includes those who are 25 or older, completed both interview and examination components, and excludes those who have missing values for education and those who reported any of the survey data by a proxy respondent. For obesity, we exclude the data before 2003 cycle because it is uncertain whether any of the weight or height variables are reported by a proxy. Also, we exclude individuals who refused to change into examination gown or did not stand up straight or wore shoes when examining weight and height. Report Marginal effects from Probit models except refusal of weight (due to very few positive refused responses). DV=1 if respondent only participated in the interview but not the examination component and 0 otherwise, DV=1 if refused to respond (or report don't know) for survey questionnaires and 0 otherwise)