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Richard V. Burkhauser, John Cawley and Maximilian D. Schmeiser

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Richard V. Burkhauser
Cornell University and NBER

John Cawley
Cornell University and NBER

Maximilian D. Schmeiser
University of Wisconsin-Madison

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Michigan Retirement Research Center
University of Michigan
P.O. Box 1248
Ann Arbor, MI 48104
http://www.mrrc.isr.umich.edu/
(734) 615-0422

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Abstract

This paper compares a variety of measures of fatness (e.g. BMI, waist circumference, waist-to-hip ratio, percent body fat) in terms of their ability to predict application for Social Security Disability Insurance (DI). This is possible through a recent linkage of the National Health and Nutrition Examination Survey (NHANES) III to Social Security Administration (SSA) administrative records.

Our results indicate that the measure of fatness that best predicts application for DI varies by race and gender. For white men, BMI consistently predicts future application for DI. For white women, almost all are consistently predictive. For black men, none predict application. For black women, waist circumference and waist-to-hip ratio are the only significant predictors of DI application. This variation across race and gender suggests that the inclusion of alternative measures of fatness in social science datasets should be considered, and that researchers examining the impact of fatness on social science outcomes should examine the robustness of their findings to alternative measures of fatness.

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Corresponding author contact information: Maximilian Schmeiser, 1300 Linden Dr, Department of Consumer Science, University of Wisconsin-Madison, Madison, WI 53706. Email: mschmeiser@wisc.edu

1. Introduction

Health is an important correlate of many economic outcomes (Culyer and Newhouse, 2000). One aspect of health that has received a considerable amount of attention in recent years is fatness, in part because obesity has roughly doubled in the U.S. in the last three decades (Hedley et al., 2004; Ogden et al., 2006).

There are many measures of fatness, each with a different threshold for obesity, but little research has been done showing the validity of these alternative fatness measures in economic modeling. There are two criteria for a measure of fatness: intrinsic validity (it should seem to actually measure fatness) and predictive validity (it should strongly predict logical outcomes). We investigate which of several measures of fatness and obesity have predictive validity with regard to application for Social Security Disability Insurance (DI). Specifically, this paper answers three questions: 1)Which measures of fatness and obesity are significantly correlated with application for Disability Insurance? 2) Does the measure of fatness or obesity influence the predictive power of the model? 3) Does the association between fatness and disability operate primarily through education, income, and marital status?

Our measures of fatness are: body mass index (BMI), total body fat (TBF), percent body fat (PBF), waist circumference (WC), and waist-to-hip ratio (WHR). BMI, which is calculated as weight in kilograms divided by height in meters squared, is the most common measure of fatness in social science research (Burkhauser and Cawley, 2008). This is because the information needed to calculate it (weight and height) are included in many social science datasets, such as the National Longitudinal Survey of Youth, the Panel Survey of Income Dynamics, and the Health and Retirement Study.

Although social scientists have relied almost exclusively on BMI as a measure of fatness, it has been criticized for its weak intrinsic and predictive validity. The primary challenge to its intrinsic validity is that it does not distinguish fat from muscle (Burkhauser and Cawley, 2008; McCarthy et al., 2006; Yusuf et al 2005; Gallagher et al 1996; Smalley et al 1990; Garn et al 1986) with the result that BMI overestimates fatness among those who are muscular (U.S. DHHS, 2001; Prentice and Jebb, 2001). Medical studies have found limited predictive validity of BMI. For example, waist circumference and waist-to-hip ratio (measures of abdominal fatness) are better predictors of mortality than BMI (Zhang et al. 2007; Hu et al. 2004; Folsom et al. 1993). Waist circumference has also been found to be a better predictor of diabetes than BMI (Klein et al. 2007). In addition, the association between waist circumference and health outcomes changes less with age than the relationship between BMI and health outcomes (Klein et al. 2007); this is likely due to waist circumference doing a better job than BMI in accounting for body composition changes (i.e. gain of fat and loss of muscle mass) with age. Many individuals classified as obese by their BMI have no cardiovascular risk factors, a finding that researchers have explained with reference to the limitations of BMI as a measure of fatness (Wildman et al., 2008).[3]

Over the same time that obesity doubled in the U.S., the number of beneficiaries in the DI program nearly doubled: from 1980 to 2007, the number of DI beneficiaries rose from 4.68 million to 8.92 million (Social Security Administration, 2008). There is considerable interest in the extent to which the two trends are related; that is, in whether obesity is associated with application for DI. Social Security Administration regulations state that obesity is in itself a

[3] There are also a few social science studies that document the limited predictive validity of BMI. For example, while BMI is associated with a lower probability of employment for white females, further examination reveals that only total body fat, and not fat-free mass, is associated with a lower probability of employment (Burkhauser and Cawley, 2008).

medically determinable impairment when it significantly limits an individual's physical or mental ability to do basic work activities (*Federal Register*, 2002). Even in less severe cases, adjudicators are instructed to consider the effects of obesity when evaluating disability. This is relevant because fatness can contribute to a variety of conditions that could lead to disability: ischemic heart disease, congestive heart failure, stroke, cancer, respiratory disease, diabetes, asthma, sleep apnea, arthritis, degenerative joint disease, and depression (Pi-Sunyer, 2002; U.S. D.H.H.S., 2001; NIH, 1998).

Several previous studies have examined the association of obesity with disability (Burkhauser and Cawley, 2005; Lakdawalla, Bhattacharya, and Goldman, 2004; Ferraro et al., 2002; Cawley 2000; Narbro et al., 1996). However, these studies define obesity using BMI.

The innovation of this paper is a comparison of various measures of fatness in terms of their ability to predict application for DI benefits. Another improvement on the previous literature (which largely used self-reported work limitations as a measure of disability) is that we use Social Security program records to determine DI application.

2. Data: National Health and Nutrition Examination Survey III

We estimate our models using the 2006 version of the restricted access National Health and Nutrition Examination Survey (NHANES) III linked Master Beneficiary Record files. The NHANES III is a nationally representative cross-sectional survey conducted from 1988 to 1994. It includes an interview component in which self-reported weight and height were recorded and a subsequent medical examination, in a large mobile examination center, where numerous additional measures of fatness were recorded. The NHANES III medical examination sample consists of 31,311 respondents.

We focus on the working age population (ages 21 to 48) for several reasons. We exclude those older than 48 at the time of the NHANES III exam (1988-94) because we need to observe respondents who are potentially eligible for the DI program for the full 10 years covered by our sample. Moreover, we want to avoid observing older applicants who face the more complicated decision of whether to apply for DI, or take early Old-Age (OA) retirement benefits or other Social Security benefits. We exclude those younger than 21 at the time of their NHANES III exam because this age group is likely to be ineligible for DI for at least part of the period we examine because of failure to achieve the minimum number of covered quarters of employment.

Hispanics are also excluded from the sample, because the sample used by other researchers to generate the Bioelectrical Impedance Analysis (BIA) conversion equations excluded Hispanics. Anyone who died within 10 years of their NHANES medical examination is excluded from the sample because they did not have the full ten years to be at risk of applying for DI. After these sample restrictions, we have complete data on 2,109 men and 2,412 women for 5 years post-examination, and 2,073 men and 2,387 women for 10 years post-examination.

Dependent Variable: Application for DI

The outcome of interest is application for Disability Insurance. Eligibility for DI depends on a determination that the applicant's disability meets or exceeds the medical listing, conditional on attaining the necessary number of covered quarters of employment.[4] We focus on application rather than acceptance because application, but not acceptance, is entirely the decision of the individual.

[4] To be eligible to receive DI benefits a claimant must have worked in employment covered by the Social Security Program for at least 20 of the previous 40 quarters. Claimants under the age of 31 can qualify for DI benefits by having worked in covered employment in at least half of the quarters that elapsed since the age of 21, with a minimum of 6 covered quarters. Blind claimants under the age of 24 can qualify for DI benefits by having worked in covered employment in at least 6 of the previous 12 quarters (SSA, 2007, Table 2.A7).

Information for application for DI is contained in the NHANES III linked Social Security Administration (SSA) Master Beneficiary Record (MBR) file, which contains Old-Age, Survivors, and Disability Insurance (OASDI) eligibility and benefit information on all NHANES III respondents who could be linked to their Social Security records, and applied for OASDI program benefits from 1962 through 2003. The SSA linked NHANES III respondents to their Social Security records using their Social Security Number, name, data of birth, sex, state of birth, and zip code (NCHS, 2006, p. 6). The SSA was able to link over 90 percent of NHANES III respondents to their Social Security records (NCHS, 2006, p. 9).[5]

Unfortunately, as these data contain Social Security eligibility information only for those persons who apply for Social Security benefits between 1962 and 2003 we are unable to separate the entire sample into those who are eligible and ineligible for benefits on the basis of employment history. This limitation biases our results towards zero, suggesting that our estimates represent a lower-bound on the effect of fatness on DI application. We are also limited to examining application for DI within 10 years of the medical examination, as we have at most 10 years of data for respondents examined in 1994. As the MBR file contains only detailed information on the most recent application for DI, we are limited to examining the most recent application for DI benefits, rather than the entire history of DI application (for this reason we cannot estimate hazard models of time until first application).

In addition to the linkage of the NHANES III to Social Security records by the SSA, the National Center for Health Statistics (NCHS) linked the NHANES III to death certificate information found in the National Death Index (NDI) from 1988 through 2000. The use of the

[5] The primary reason an NHANES III respondent could not be linked to their Social Security record was refusal by the NHANES III respondent to provide their Social Security Number. Missing data on last name and date of birth also resulted in linkage failures (NCHS, 2006, p. 6).

NHANES III linked Mortality file allows for the exclusion of respondents who died during the sample period.

Application for DI benefits within 5 years or 10 years of the physical examination is determined in the following manner. The Beneficiary Identification code (BIC) at their date of current eligibility for benefits must have been coded "primary claimant/number holder" and their type of claim (TOC) had to be "disability care where beneficiary is: a) disabled primary not reduced for age; b)aged or divorced wife/husband not reduced for age; c) young wife entitled for young child-in-care; d) young child" or "disability case where beneficiary is: a) disabled primary reduced for age; b) aged or divorced wife/husband reduced for age".

We include both applicants who received DI benefits and those who were denied DI benefits in our sample. We can identify whether or not an applicant was denied benefits, and the reason for that denial, based on the variable Ledger Account File (LAF). Reasons for denial include failing to meet the medical listings for disability, or having insufficient covered quarters of employment (uninsured).[6]

Regressors of Interest: Measures of Fatness and Obesity

The NHANES provides the most comprehensive set of measures of fatness of any large, nationally-representative survey in the United States. It includes: Bioelectrical Impedance Analysis (BIA) readings that can be used to calculate fat-free mass and therefore total body fat and percent body fat, skinfold thicknesses that can be used to calculate percent body fat, measured weight and height, self-reported weight and height, measured waist circumference, and

[6] In our 5 year sample, 3 men and 6 women were denied benefits due to being uninsured, while 28 men and 19 women were denied benefits due to not meeting the medical listings out of a total of 69 applications for men and 70 applications for women. In our 10 year sample, 10 men and 21 women were denied benefits due to being uninsured, while 55 men and 51 women were denied benefits due to not meeting the medical listings out of a total of 147 applications for men and 161 applications for women. Estimates were also obtained for a sample which excluded persons denied coverage on the basis of being uninsured. This had no significant effect on the coefficient estimates and these results are available upon request.

measured waist-to-hip ratio. A limitation of the NHANES is that it is cross-sectional; it includes measurements of fatness from the medical examination (1988-1994) but not thereafter. Thus, we are only able to compare baseline fatness or obesity to application for DI up to 5 or 10 years later, without controlling for how fatness or obesity may have changed in the interim.[7] By linking Social Security administrative records to the cross-sectional NHANES III we are able to take full advantage of the limited longitudinal nature of the combined data.

TBF may be the most relevant measure of fatness if the sheer volume of fat determines the health consequences (Trayhurn and Beattie, 2001). Alternatively, PBF may be a better measure if additional fat-free-mass can dilute the health impacts of fatness. There are a variety of ways of measuring TBF and PBF. The NHANES includes readings from BIA, which can be used to calculate TBF and PBF (Burkhauser and Cawley, 2008). The NIH classifies a man as obese if his PBF exceeds 25 percent and a woman as obese if her PBF exceeds 30 percent (NIDDK, 2006).

The NHANES III also includes measurements of tricep and subscapular skinfold thicknesses. These skinfold measures can be converted into percent body fat following a two-step process. First, body density is predicted using tricep and subscapular skinfold thicknesses based on the age and gender specific formulas provided in Durnin and Womersley (1974). Second, percent body fat was computed using body density using the Siri (1956) conversion equation.

Findings from the medical literature also suggest that it is not just the amount of fat that matters, but also the location or distribution of that fat. The NHANES includes two measures of central adiposity or abdominal fat: waist circumference or waist-to-hip ratio. The NIH classifies

[7] In general, those obese in early adulthood tend to be obese later as well; e.g. Brown et al. (2007) calculate that in the NHANES I follow-up 77 percent of men and 85 percent of women who were obese at age 25-29 were also obese at age 40-44. As people age, they tend to lose muscle mass and gain fat mass (Zamboni et al., 2005; Elia, 2001).

individuals at “high risk” if waist circumference exceeds 102 cm (40 inches) for men or exceeds 88 cm (35 inches) for women (NIH, 1998, p. xv). For waist-to-hip ratios, Han et al. (1995) find an increased prevalence of cardiovascular risk factors if waist-to-hip ratio is greater than or equal to 0.95 for men, or is greater than or equal to 0.80 for women. Hence we also look at waist-to-hip ratios and waist circumference, as well as indicators for being at “high risk” based on the respective measure of central adiposity.

The inclusion of both measured weight and height, and self-reported weight and height in the NHANES III allows for the calculation of BMI values and corresponding indicators for obesity from measured and self-reported values. Though BMI based on measured weight and height is more accurate than BMI based on self-reported weight and height, we also examine self-reported BMI due to its greater availability in social science data sets.

Previous research by Cawley and Burkhauser (2006) using the NHANES III identified systematic differences between self-reported weight and height and measured weight and height by race and gender. In order to allow researchers using data sets which include only self-reported values to adjust for the self-report bias in weight and height, they provide regression coefficients by sex and race, which can be applied to self-reported weight and height, and age to predict measured weight and height. Given that the convention in economic literature examining BMI is to use these adjustment factors, we also examine adjusted BMI and the corresponding indicator for obesity.

Descriptive Statistics

Table 1 presents descriptive statistics for the sample, by gender and application period (5 or 10 years). In the first five years after the NHANES III medical exam, 69 men (3.3 percent) and 70 women (2.9 percent) applied for DI benefits. Within ten years of the exam, 147 men (7.1

percent) and 161 women (6.7 percent) applied for DI. All of our regressors correspond to the time of the medical exam (1988-94), so there are few differences between the summary statistics for the 5 and 10 years samples. For the sake of brevity only the summary statistics for the 5 year sample are discussed here. Age at the time of the medical exam averaged 414.7 months 414.7 months (34.56 years) for men and 415.2 months (34.60 years) for women. A high school diploma was the highest educational attainment of 36.9 percent of men and 41.0 percent of women. The fraction of the sample with some education beyond high school was 44.0 percent for men and 42.1 percent of women. A bare majority of respondents were married (55.4 percent of men and 51.3 percent of women). The modal family income category was $10,000 to $19,999, with the median respondent having a family income of $20,000 to $29,999, for both men and women.

Using the BIA method of calculating fat-free mass and total body fat[8], the average male in the 5 year sample had 63.5 kg of fat free mass and 19.6 kg of body fat, while the average female had 46.0 kg of fat free mass and 26.1 kg of body fat. The average percent body fat was 22.7 among men and 34.5 among women. PBF calculated using skinfold thicknesses was considerably lower: it averaged 13.7 for males and 29.2 for females.

Using measured height and weight, the average male in the 5 year sample had a BMI of 26.4, while the average female had a BMI of 26.9. There were minimal differences between the average BMI values calculated using either measured height and weight, self-reported height and weight, or adjusted self-reported height and weight.

The average waist circumference is 92.2 cm among men and 87.7 cm among women. When waist circumference is dichotomized into an indicator for excessive fatness, 19.8 percent

[8] See Burkhauser and Cawley (2008).

of males and 41.6 percent of females are classified as “high risk” (WC>102 cm for men, WC>88 cm for women).

The average waist-to-hip ratio in the 5 year sample was 0.922 among men, and 0.844 among women. Dichotomizing waist-to-hip ratio into an indicator for excessive fatness, 29.9 percent of males and 72.4 percent of females are classified as “high risk” (WHR≥ 0.95 for men, WHR≥ 0.85 cm for women).

Based on PBF from BIA, the prevalence of obesity (PBF>25 for men, PBF>30 for women) was 36.9 percent among men and 70.2 percent among women. Based on measured BMI, the prevalence of obesity (BMI ≥ 30) was 18.9 percent among men and 26.9 percent among women. The much lower prevalence of obesity when calculated using BMI relative to PBF is consistent with the results of Burkhauser and Cawley (2008).

3. Models to Estimate the Correlation of Fatness with Application for DI Benefits

A substantial literature in economics models the decision of workers to apply for DI following the onset of a disability; see Bound and Burkhauser (1999) and Stapleton and Burkhauser (2003) for reviews of the literature. Data limitations have required the vast majority of these studies to use self-reports of disability or DI receipt, and, in the rare instance when information on fatness was available, it was in the form of self-reported weight (utilized in conjunction with self-reported height as BMI). An important contribution of this paper is that it makes use of social security records that provide objective information on DI application and approval, and it makes use of a large number of measurements of fatness. In other words, the quality of the data is high on both sides of the equation predicting disability using fatness.

We assume that individual *i* applies for DI benefits if his health H_i falls below some critical limit H^*. Health is assumed to be a function of fatness F_i and other characteristics X_i. Specifically:

$$H_i = F_i \beta + X_i \delta + u_i$$

Health *H* is not observed, but we know whether an individual applies for DI benefits; we denote *DI_app=1* if individual *i* applies for DI benefits and *DI_app=0* otherwise. Formally, applying for DI benefits relates to latent health in the following way:

$$DI\_app_i = 0 \text{ if } H_i \geq H^* \text{ or } DI\_app_i = 1 \text{ if } H_i < H^*$$

Normalizing H^* at $H=0$, the probability that one applies for DI benefits is equal to the following.

(1) $$\Pr[DI\_app_i = 1 \mid F_i, X_i] = \Pr[u_i < - F_i\beta - X_i\delta]$$

With certain assumptions about the distribution of the error term *u*, one can estimate the probability of applying for DI benefits as a function of fatness *F* and characteristics *X* using probit regression.

We estimate model (1) for the following measures of fatness: total body fat and fat-free mass from BIA, percent body fat from BIA, percent fat-free mass from BIA, percent body fat from skinfolds, body mass index from measured weight and height, body mass index from self-reported weight and height, body mass index from adjusted self-reported weight and height, waist circumference, waist-to-hip ratio, and indicators for obesity based on each measure of fatness. Control variables include: age and age squared at time of NHANES III examination, education category, marital status, family income to poverty cut-off ratio, and family income category.

Some potential regressors may themselves be determined by fatness. As such, models are first estimated which include only those variables which are completely exogenous: age and age squared.[9] By excluding variables which are potentially determined by fatness, these bare-bones models measure the total correlation of fatness with DI application. We subsequently estimate models which add education, marital status, the ratio of family income to the poverty threshold, and family income category. By adding these controls, we can determine the extent to which the correlation of fatness with DI application operates through these variables. For example, income may prove to be a relevant pathway because previous research has determined that for white females, weight and obesity lower wages (Cawley, 2004).

We take into account the complex survey design of the NHANES III by estimating our models using the svyprobit command in Stata version 10. The NHANES III sample weights named WTPFEX6 are used because they are recommended when studying medical examination variables such as weight and the other measures of fatness.

4. Results

We first estimate probit models of application for DI within 5 years or 10 years of the medical examination that control only for the exogenous variables age (at time of NHANES III examination) and age squared. Models are estimated separately for white males, white females, black males, and black females (all Hispanics are excluded). Separate models are estimated for each of our measures of fatness and corresponding indicators for excessive fatness or obesity. Tables 2-5 report the results of these models; each cell of the table reports the marginal effect, z-statistic of the coefficient, and the percent correct predictions.

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[9] Models were estimated with two different sets of controls for age. In the first specification age and age squared were included as regressors. In the second specification indicators for age were used. The two specifications yield nearly identical results, and so we report only the results for the specification including age and age squared in this paper.

Which measures of fatness and obesity are significantly correlated with application for Disability Insurance?

Table 2 presents results from the probit models for DI application by sex and application time period for whites. For white males (column 1), application for DI within 5 years of the medical exam is not significantly correlated with any measure of fatness or obesity. Still, some of the point estimates of the marginal effects of certain measures of obesity are large; for example, obesity defined by measured BMI is associated with a 1.46 percentage point higher probability of applying for DI. Marginal effects for obesity defined using self-reports or self-reports adjusted for reporting error are even higher: 3.2 and 2.2 percentage points. To put these marginal effects in context, only 2.3 percent of white males applied for DI in the first five years.

When the time for application for DI is extended to 10 years from the time of the medical examination (Table 2, column 2) all three continuous measures of BMI have the expected signs, and become statistically significant at least at the 10 percent level. A one unit increase in measured BMI is associated with a 0.23 percentage point increase in the probability of applying for DI within 10 years. Obesity based on each of the three measures of BMI is also now statistically significant at least at the 10 percent level. Obesity based on measured BMI is associated with a 3.4 percentage point increase in the probability of applying for DI benefits within 10 years; again, the marginal effects for obesity defined using self-reports or self-reports adjusted for reporting error are even higher: 5.9 and 4.5 percentage points. To put these marginal effects in context, 4.8 percent of white males applied for DI in the ten years after the medical exam.

Table 2 also lists results of the model estimated using the sample of white females. While no measure of fatness or obesity was significantly correlated with application for DI in the first five years for men, there are several such correlations for women. Each of the three measures of BMI (based on measurements, self reports, or self reports corrected for reporting error), and waist circumference are all associated with a higher probability of applying for DI benefits within five years of the medical exam. In addition, obesity based on BMI (calculated from self-reported weight and height) is associated with a 2.5 percentage point increase in the probability of application for DI, and a high-risk waist circumference is associated with a 2.8 percentage point increase in the probability of application for DI within five years. To put these marginal effects in context, 1.8 percent of white females applied for DI benefits within the first five years of the medical exam.

Column 4 of Table 2 presents results for application within ten years by white females. Almost all of the measures of fatness and obesity are significantly and positively correlated with application for DI benefits within ten years; specifically: total body fat (controlling for fat-free mass), percent body fat (both calculated using BIA and calculated using skinfolds), the three measures of BMI, waist circumference, and waist-to-hip ratio. Moreover, percent fat free mass is significantly and negatively associated with application. Obesity based on percent body fat (calculated using skinfolds), BMI (calculated any of the three ways), and a high-risk waist circumference are all associated with a higher probability of application. The magnitude of the marginal effects of obesity range from 2.4 percentage points (obese by PBF) to 6.0 (obese by self-reported BMI). To put these magnitudes in context, 4.8 percent of the white female sample applied for DI benefits in the ten years of the medical exam.

Results of the basic model for blacks are presented in Table 3. Among black men, no measure of fatness or obesity significantly predicts application for DI in either the five or ten year period after the medical examination. This is not simply due to a smaller sample for black men than white men; because of over-sampling of minorities the sample sizes are similar (1,083 white men and 1,026 black men). In our sample, the probability of applying for DI is much higher for black men (6.7 percent apply within five years, and 14.7 percent apply within ten years) than the white men (2.3 percent apply within five years, and 4.8 percent apply within ten years). In addition, the point estimates for black men are considerably smaller in magnitude: e.g. the point estimate of the marginal effect of obesity based on BMI (calculated using measured weight and height) on the probability of applying for DI within ten years of the medical exam is 3.4 percentage points for white men and 1.4 percentage points for black men.

Among black women (Table 3, columns 2 and 3), waist-to-hip ratio is associated with a higher probability of DI application in both the 5 and 10 year time frame. Waist circumference and having a high-risk waist circumference are positively and significantly correlated with application in the first five years after the medical exam, and a high-risk waist circumference also is positively and significantly correlated with application in the first ten years after the medical exam. Obesity defined by BMI based on self-reported weight and height adjusted for reporting error also is significantly and positively correlated with application in the five-year period. Again, the magnitudes of the point estimates for obesity are large; a high-risk waist circumference is associated with a 2.1 percentage point increase in the probability of application within 5 years and a 3.2 percentage point increase in the probability of application within 10 years. For the sake of comparison, 5.9 percent of black women applied for DI within five years, and 13.7 percent applied within ten years.

Does the measure of fatness or obesity influence the predictive power of the model?

The model's percent of correct predictions does not vary much with the measure of fatness or obesity used. For example, for white men (Table 2), every model for application within 5 years of the medical exam has a percent of correct predictions in the range of 95.5 and 96.1 percent, and every model for application within 10 years has a percent of correct predictions in the range of 91.2 and 91.9 percent.

How much of the association between fatness and disability operates through education, income, and marital status?

We next estimate models of DI application that add controls for education, marital status, family income to poverty line ratio, and family income category to the previous controls of age at exam and age squared. These results are presented in Tables 4 (for whites) and 5 (for blacks). Comparing basic model results to those of the fuller model indicates the extent to which the association of fatness or obesity with DI application operates through education, income, and marital status.

Comparing Table 4 to Table 2, it is apparent that adding additional controls has little impact on the magnitude or significance of the marginal effects for white men. Once again no measure of fatness or obesity is associated with DI application within 5 years of the medical exam. When we consider DI application up to 10 years from the medical exam, the addition of controls does not change our previous finding that the three measures of BMI (based on measurements, self-reports, or self-reports corrected for reporting error) and the three measures of obesity based on those three measures of BMI are positively and significantly correlated with application. The addition of the controls also has little impact on the point estimates of the marginal effects; for example, obesity based on BMI calculated using measurements is associated with a 3.4 percentage point increase in the probability of applying for DI within 10 years in the bare-bones model; after adding the additional controls for education, income, and marital status, that point estimate is 3.5 percentage points.

For white women, adding the controls for education, income, and marital status to the model for DI application within 5 years result in the marginal effects of each measure of BMI and the measures of obesity based on BMI (calculated using self-reports) and high-risk waist circumference to lose statistical significance. This is largely due to reductions in the point estimates of the marginal effects. For example, in the basic model, obesity defined by BMI (calculated using self-reports) is associated with a 2.5 percentage point increase in the probability of applying for DI within 5 years, but after adding the additional controls that marginal effect falls to 1.4 percentage points.

In the models for application within 10 years of the medical exam estimated using the sample of white females, most of the same measures of fatness and obesity are significant in both the basic model and the model with added regressors, although the point estimates tend to be smaller in the latter.

Table 5 presents results for the models with added regressors estimated using the samples of black males and black females. The additional control variables do not change our previous findings that none of our fatness or obesity measures predict whether black males apply for DI within either 5 or 10 years of the medical exam.

For black females, the additional controls result in few changes. The measures of central adiposity (waist circumference and waist-to-hip ratio) remain most predictive of application. Specifically, waist circumference and waist-to-hip ratio, and having a high-risk waist circumference are positively and significantly correlated with the probability of DI application within 5 years. A high-risk waist circumference is also positively and significantly correlated with the probability of DI application within 10 years. Comparing Table 5 to Table 3 reveals that the added regressors have little impact on the point estimates of the marginal effects, with the exception that waist-to-hip ratio is no longer significant in models of application for DI within 10 years. In addition, obesity defined by BMI (based on measurements) has a slightly larger marginal effect and is now statistically significant in predicting application within 5 years of the medical exam, after adding the additional controls for education, marital status, and income.

5. Discussion

Using high quality data on both DI application (based on Social Security records) and on fatness (measured by medical professionals during the NHANES medical examination) we set out to answer three questions.

1) Which measures of fatness and obesity are significantly correlated with application for Disability Insurance? The existing research regarding the impact of fatness on disability has consistently found that obese individuals (determined using BMI) are more likely to report work limitations or to report receiving DI benefits (Ferraro et al., 2002; Burkhauser and Cawley, 2005). Building on that literature we find that the measures of fatness and obesity that are correlated with application for DI varies dramatically by race and gender group. None of our measures of fatness or obesity predicts the DI application of black men. For white men, only BMI and obesity based on BMI consistently predict DI application. In contrast, for our samples of black women and white women our fatness and obesity measures are better predictors of DI application. Measures of abdominal fatness (waist circumference, high-risk waist circumference, and waist-to-hip ratio) are the most consistently predictive of DI application for black women. For white women, virtually every measure of fatness and obesity predicts DI application within 10 years of the medical exam. One possibility for why fatness and obesity are more predictive of

DI application among women than men may be that men are engaged in more risky occupations, so there are more competing risks for disability.

In general, the point estimates of the marginal effects of obesity on DI application are large. They are approximately one quarter of the unconditional probability of application for blacks. For whites they are even larger—approximately equivalent to the unconditional probability of their application. The marginal effect tends to be larger for obesity based on BMI calculated using self-reports because people under-report their weights (e.g. Rowland 1989), so those whose reports are consistent with obesity are the truly extreme obese, among whom one would expect a higher probability of application.

Our finding that BMI is less predictive of DI application for blacks than whites is consistent with our previous findings that BMI is a less accurate measure of fatness for blacks than whites (Burkhauser and Cawley, 2008). Specifically, BMI results in significantly higher percentages of false positives (misclassification of non-obese people as obese) for blacks than whites of the same gender (when percent body fat measured by PBF is used to determine the true obesity status). Given that BMI is a worse measure of fatness for blacks than whites, it is not surprising that BMI would also be less predictive of the health consequences of fatness for blacks than whites.[10]

Our findings also indicate that measures of abdominal fatness (waist circumference and waist-to-hip ratio) are predictive of DI application for women but not men. A recent consensus document concluded that it is unclear whether waist circumference is generally more predictive of obesity-related outcomes for women than men (Klein et al. 2007).

[10] Likewise, the consistent finding that the labor market penalty of obesity (calculated using BMI) is less for black women than for white women (e.g. Cawley 2004; Averett and Korenman, 1996, 1999) may be due to BMI being a worse measure of fatness for blacks than whites.

2) Does the measure of fatness or obesity influence the predictive power of the model? Our findings suggest that the measure of fatness or obesity does not greatly impact the predictive power of the model. We do however observe that the percent correct predictions of the model are lower when we examine DI application within 10 years than within 5 years, probably because of competing risks associated with age.

3) Does the association between fatness and disability operate primarily through education, income, and marital status? Our findings suggest that little of the association operates through those variables; adding those variables as regressors has very little impact on the point estimates of the marginal effects.

Our bottom line conclusion is that, as suggested in Burkhauser and Cawley (2008), the measure of fatness most associated with outcomes of interest to social scientists depends on the population of interest (e.g. gender, race). However, at least with respect to DI application, the specific measure of fatness or obesity chosen has little impact on the overall predictive power of the model. In general, research into the impact of fatness on various outcomes of interest to social scientists would benefit from wider availability of alternative measures of fatness in the data sets most commonly used by social scientists. A measure of abdominal fatness such as waist circumference appears to be a particularly good addition, as it may predict the health consequences of obesity well for women (in particular, black women).

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Table 1. Descriptive statistics for Combined Sample

	Mean (Standard deviation)			
	Men		Women	
	Application for DI within:		Application for DI within:	
Variables:	5 years	10 years	5 years	10 years
Age in Months at Exam	414.737	413.450	415.227	414.738
	(92.455)	(92.163)	(89.732)	(89.687)
High School	0.369	0.368	0.410	0.410
	(0.483)	(0.482)	(0.492)	(0.492)
Greater than High School	0.440	0.445	0.421	0.422
	(0.497)	(0.497)	(0.494)	(0.494)
Married	0.554	0.555	0.513	0.516
	(0.497)	(0.497)	(0.500)	(0.500)
Divorced	0.065	0.066	0.122	0.120
	(0.247)	(0.248)	(0.328)	(0.325)
Separated	0.028	0.027	0.054	0.054
	(0.166)	(0.162)	(0.226)	(0.227)
White	0.514	0.517	0.508	0.509
	(0.500)	(0.500)	(0.500)	(0.500)
Black	0.486	0.483	0.492	0.491
	(0.500)	(0.500)	(0.500)	(0.500)
Family Income from $0 to $9,999	0.115	0.110	0.158	0.156
	(0.319)	(0.313)	(0.364)	(0.363)
Family Income from $10,000 to $19,999	0.230	0.231	0.223	0.222
	(0.421)	(0.422)	(0.416)	(0.416)
Family Income from $20,000 to $29,999	0.174	0.175	0.170	0.170
	(0.380)	(0.380)	(0.376)	(0.376)
Family Income from $30,000 to $39,999	0.163	0.164	0.138	0.138
	(0.370)	(0.371)	(0.345)	(0.345)
Family Income from $40,000 to $49,999	0.125	0.123	0.121	0.122
	(0.330)	(0.329)	(0.327)	(0.328)
Family Income >$50,000	0.193	0.196	0.190	0.191
	(0.395)	(0.397)	(0.393)	(0.394)
Fat Free Mass	63.518	63.492	46.049	45.995
	(10.285)	(10.263)	(7.374)	(7.353)
Total Body Fat	19.608	19.600	26.083	26.010
	(9.456)	(9.397)	(12.415)	(12.395)
Percent Body Fat (PBF)	22.686	22.699	34.467	34.430
	(6.697)	(6.649)	(8.011)	(8.012)
Percent Body Fat (Skinfold)	13.726	13.691	29.189	29.122
	(11.199)	(11.146)	(14.814)	(14.811)
Percent Fat Free Mass	77.314	77.301	65.533	65.570
	(6.697)	(6.649)	(8.011)	(8.012)
Body Mass Index (Measured)	26.369	26.359	26.873	26.834
	(5.078)	(5.050)	(6.820)	(6.808)
Body Mass Index (Self-reported)	26.222	26.205	26.244	26.200
	(4.499)	(4.476)	(6.167)	(6.149)
Body Mass Index (Self-reported, Adjusted)	26.284	26.265	26.935	26.887
	(4.838)	(4.813)	(6.491)	(6.471)
Waist Circumference (WC)	92.175	92.126	87.681	87.565
	(13.725)	(13.656)	(15.847)	(15.811)
Waist-to-Hip Ratio (WHR)	0.922	0.921	0.844	0.843
	(0.068)	(0.068)	(0.077)	(0.077)
Obese PBF	0.369	0.370	0.702	0.700
	(0.483)	(0.483)	(0.458)	(0.458)
Obese Skinfold	0.164	0.162	0.523	0.521
	(0.370)	(0.368)	(0.500)	(0.500)
Obese BMI Measured	0.189	0.187	0.269	0.267
	(0.391)	(0.390)	(0.444)	(0.442)
Obese BMI Self-reported	0.156	0.154	0.224	0.221
	(0.363)	(0.361)	(0.417)	(0.415)
Obese BMI Self-reported, Adjusted	0.169	0.168	0.261	0.258
	(0.375)	(0.374)	(0.439)	(0.437)
High Risk WC	0.198	0.196	0.416	0.413
	(0.398)	(0.397)	(0.493)	(0.492)
High Risk WHR	0.299	0.298	0.724	0.721
	(0.458)	(0.457)	(0.447)	(0.448)
Applied for DI	0.033	0.071	0.029	0.067
	(0.178)	(0.257)	(0.168)	(0.251)
Sample Size	2109	2073	2412	2387

Table 2. Social Security Disability Insurance Application Probits for Non-Hispanic White Persons Ages 21 to 48

	Men		Women	
	Application for DI within:		Application for DI within:	
Measure of Fatness:	5 years	10 years	5 years	10 years
Total Body Fat (w/ Fat Free Mass)	-0.00123	-0.00009	0.00089	0.00237**
	(-1.21)	(-0.087)	(1.43)	(2.65)
	[0.95937]	[0.91418]	[0.96578]	[0.92669]
Fat Free Mass (w/ Total Body Fat)	0.00046	0.00087	-0.00044	-0.00209
	(0.66)	(0.99)	(-0.57)	(-1.08)
	[0.95937]	[0.91418]	[0.96578]	[0.92669]
Percent Body Fat (BIA)	-0.00156	-0.00100	0.00088	0.00206**
	(-1.40)	(-0.73)	(0.98)	(2.32)
	[0.96122]	[0.91791]	[0.96749]	[0.92257]
Percent Body Fat (skinfold)	-0.00052	-0.00023	0.00042	0.00099**
	(-0.76)	(-0.36)	(1.28)	(2.41)
	[0.95845]	[0.91698]	[0.96749]	[0.92422]
Percent Fat Free Mass	0.00156	0.00100	-0.00088	-0.00206**
	(1.40)	(0.73)	(-0.98)	(-2.32)
	[0.96122]	[0.91791]	[0.96749]	[0.92257]
Body Mass Index (measured)	-0.00008	0.00228*	0.00117*	0.00261***
	(-0.053)	(1.87)	(1.70)	(3.24)
	[0.95937]	[0.91791]	[0.96749]	[0.92586]
Body Mass Index (self-reported)	-0.00011	0.00265**	0.00117*	0.00272***
	(-0.070)	(2.02)	(1.89)	(2.98)
	[0.95937]	[0.91978]	[0.96749]	[0.92422]
Body Mass Index (self-reported, adjusted)	-0.00019	0.00251**	0.00112*	0.00252***
	(-0.13)	(2.03)	(1.81)	(2.78)
	[0.95937]	[0.91884]	[0.96749]	[0.92257]
Waist Circumference	-0.00021	0.00063	0.00072**	0.00125***
	(-0.35)	(1.27)	(2.44)	(2.99)
	[0.95937]	[0.91604]	[0.96749]	[0.92504]
Waist-to-Hip Ratio	0.00466	0.15039	0.07869*	0.12859*
	(0.053)	(1.22)	(1.84)	(1.84)
	[0.95937]	[0.91791]	[0.96578]	[0.91763]
Obese by PBF (BIA)	-0.00221	-0.00131	0.01377	0.02135
	(-0.21)	(-0.12)	(1.28)	(1.56)
	[0.95937]	[0.91604]	[0.96749]	[0.91598]
Obese by PBF (skinfold)	-0.00988	0.01423	0.01319	0.02370**
	(-0.99)	(0.88)	(1.41)	(2.09)
	[0.95937]	[0.91511]	[0.96578]	[0.92092]
Obese by BMI (measured)	0.01461	0.03378*	0.01674	0.04378***
	(0.72)	(1.73)	(1.33)	(2.72)
	[0.95568]	[0.91231]	[0.96749]	[0.92257]
Obese by BMI (self-reported)	0.03244	0.05851**	0.02468*	0.05966***
	(1.23)	(2.20)	(1.69)	(2.88)
	[0.95845]	[0.91511]	[0.96749]	[0.92998]
Obese by BMI (self-reported, adjusted)	0.02232	0.04494*	0.01490	0.04496**
	(0.94)	(1.79)	(1.23)	(2.51)
	[0.95845]	[0.91698]	[0.96578]	[0.92586]
High Risk WC	0.00527	0.02274	0.02813**	0.03485**
	(0.31)	(1.14)	(2.20)	(2.61)
	[0.95660]	[0.91418]	[0.96749]	[0.91928]
High Risk WHR	0.00189	0.01459	0.01175	0.00677
	(0.13)	(1.03)	(1.33)	(0.54)
	[0.95937]	[0.91604]	[0.96749]	[0.91516]
Number of Applications	25	51	21	58
Sample Size	1083	1072	1169	1214

Coefficients are marginal effects. z-statistics in parentheses. Percent of applicants correctly predicted in brackets. $*p < 0.10$, $**p < 0.05$, and $***p < 0.01$. The models also include age at exam and age at exam squared.

Table 3. Social Security Disability Insurance Application Probits for Non-Hispanic Black Persons Ages 21 to 48

	Men		Women	
	Application for DI within:		Application for DI within:	
Measure of Fatness:	5 years	10 years	5 years	10 years
Total Body Fat (w/ Fat Free Mass)	0.00015	-0.00092	-0.00020	-0.00045
	(0.11)	(-0.60)	(-0.32)	(-0.45)
	[0.91813]	[0.84216]	[0.92586]	[0.85678]
Fat Free Mass (w/ Total Body Fat)	0.00019	0.00168	0.00153	0.00210
	(0.21)	(1.21)	(1.02)	(1.06)
	[0.91813]	[0.84216]	[0.92586]	[0.85678]
Percent Body Fat (BIA)	-0.00008	-0.00129	0.00048	-0.00002
	(-0.048)	(-0.75)	(0.70)	(-0.022)
	[0.92008]	[0.83417]	[0.91997]	[0.85422]
Percent Body Fat (skinfold)	0.00032	-0.00013	0.00025	-0.00006
	(0.45)	(-0.14)	(0.52)	(-0.086)
	[0.91813]	[0.83616]	[0.92165]	[0.85422]
Percent Fat Free Mass	0.00008	0.00129	-0.00048	0.00002
	(0.048)	(0.75)	(-0.70)	(0.022)
	[0.92008]	[0.83417]	[0.91997]	[0.85422]
Body Mass Index (measured)	0.00052	0.00061	0.00113	0.00132
	(0.42)	(0.40)	(1.26)	(0.90)
	[0.91813]	[0.83616]	[0.92165]	[0.85507]
Body Mass Index (self-reported)	0.00079	0.00052	0.00057	0.00086
	(0.67)	(0.31)	(0.60)	(0.52)
	[0.91813]	[0.83816]	[0.91997]	[0.85507]
Body Mass Index (self-reported, adjusted)	0.00071	0.00078	0.00059	0.00082
	(0.66)	(0.52)	(0.65)	(0.53)
	[0.91813]	[0.83816]	[0.91997]	[0.85507]
Waist Circumference	0.00017	0.00015	0.00065*	0.00078
	(0.30)	(0.21)	(1.85)	(1.30)
	[0.91813]	[0.83616]	[0.92334]	[0.85337]
Waist-to-Hip Ratio	0.00540	-0.04677	0.15520**	0.20426**
	(0.040)	(-0.29)	(2.71)	(2.10)
	[0.91618]	[0.83616]	[0.92081]	[0.85166]
Obese by PBF (BIA)	0.01119	0.01113	-0.00529	-0.01827
	(0.66)	(0.50)	(-0.37)	(-0.98)
	[0.92008]	[0.83616]	[0.92586]	[0.85934]
Obese by PBF (skinfold)	0.00727	0.00581	-0.00897	-0.00795
	(0.37)	(0.23)	(-0.64)	(-0.42)
	[0.91715]	[0.83616]	[0.92671]	[0.85934]
Obese by BMI (measured)	0.01082	0.01372	0.02552	0.02881
	(0.61)	(0.59)	(1.63)	(1.35)
	[0.91715]	[0.83616]	[0.92249]	[0.85251]
Obese by BMI (self-reported)	0.01146	0.02983	0.01522	0.01698
	(0.58)	(1.05)	(0.91)	(0.70)
	[0.91813]	[0.84016]	[0.92502]	[0.85422]
Obese by BMI (self-reported, adjusted)	0.00585	0.02721	0.02382	0.01831
	(0.31)	(1.00)	(1.66)	(0.87)
	[0.91715]	[0.84216]	[0.92334]	[0.85337]
High Risk WC	0.00812	0.01612	0.02148**	0.03160*
	(0.40)	(0.56)	(2.17)	(1.87)
	[0.91520]	[0.83616]	[0.91744]	[0.85337]
High Risk WHR	0.00937	0.00761	0.01104	0.01659
	(0.43)	(0.33)	(0.83)	(0.84)
	[0.91618]	[0.83916]	[0.92081]	[0.85678]
Number of Applications	44	96	49	103
Sample Size	1026	1001	1187	1173

Coefficients are marginal effects. z-statistics in parentheses. Percent of applicants correctly predicted in brackets. *$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$. The models also include age at exam and age at exam squared.

Table 4. Social Security Disability Insurance Application Probits for Non-Hispanic White Persons Ages 21 to 48, with Family Income

	Men		Women	
	Application for DI within:		Application for DI within:	
Measure of Fatness:	5 years	10 years	5 years	10 years
Total Body Fat (w/ Fat Free Mass)	-0.00137	-0.00049	0.00049	0.00183**
	(-1.46)	(-0.46)	(0.87)	(2.34)
	[0.96030]	[0.92817]	[0.97006]	[0.92504]
Fat Free Mass (w/ Total Body Fat)	0.00072	0.00145	0.00004	-0.00122
	(1.09)	(1.61)	(0.056)	(-0.77)
	[0.96030]	[0.92817]	[0.97006]	[0.92504]
Percent Body Fat (BIA)	-0.00164	-0.00099	0.00055	0.00171*
	(-1.57)	(-0.76)	(0.66)	(1.88)
	[0.96030]	[0.93377]	[0.96835]	[0.92669]
Percent Body Fat (skinfold)	-0.00045	0.00016	0.00025	0.00081*
	(-0.76)	(0.25)	(0.84)	(1.90)
	[0.96122]	[0.93097]	[0.96835]	[0.92916]
Percent Fat Free Mass	0.00164	0.00099	-0.00055	-0.00171*
	(1.57)	(0.76)	(-0.66)	(-1.88)
	[0.96030]	[0.93377]	[0.96835]	[0.92669]
Body Mass Index (measured)	-0.00011	0.00220*	0.00088	0.00233**
	(-0.091)	(1.95)	(1.18)	(2.52)
	[0.95937]	[0.92724]	[0.97006]	[0.92669]
Body Mass Index (self-reported)	-0.00035	0.00225*	0.00074	0.00233**
	(-0.29)	(1.88)	(1.10)	(2.23)
	[0.96307]	[0.92724]	[0.96835]	[0.92916]
Body Mass Index (self-reported, adjusted)	-0.00038	0.00221*	0.00071	0.00218**
	(-0.33)	(1.94)	(1.07)	(2.12)
	[0.96307]	[0.92724]	[0.96664]	[0.92669]
Waist Circumference	-0.00021	0.00063	0.00057*	0.00107**
	(-0.43)	(1.36)	(1.80)	(2.24)
	[0.96122]	[0.92910]	[0.96749]	[0.92669]
Waist-to-Hip Ratio	-0.04142	0.03475	0.04417	0.07743
	(-0.52)	(0.31)	(1.18)	(0.97)
	[0.96307]	[0.93097]	[0.96835]	[0.92422]
Obese by PBF (BIA)	-0.00165	-0.00106	0.01292	0.02130
	(-0.17)	(-0.091)	(1.21)	(1.59)
	[0.96122]	[0.92910]	[0.96835]	[0.92422]
Obese by PBF (skinfold)	-0.01003	0.01360	0.00853	0.01870*
	(-1.05)	(0.81)	(0.96)	(1.68)
	[0.96122]	[0.93097]	[0.96835]	[0.92751]
Obese by BMI (measured)	0.01556	0.03530*	0.00870	0.03187*
	(0.93)	(1.88)	(0.74)	(1.94)
	[0.95937]	[0.92724]	[0.96664]	[0.92916]
Obese by BMI (self-reported)	0.02807	0.05167**	0.01352	0.04617**
	(1.34)	(2.28)	(1.09)	(2.26)
	[0.95753]	[0.92537]	[0.96835]	[0.92916]
Obese by BMI (self-reported, adjusted)	0.01794	0.03850*	0.00674	0.03506*
	(0.94)	(1.74)	(0.61)	(1.90)
	[0.95937]	[0.92537]	[0.96664]	[0.92751]
High Risk WC	0.00615	0.02172	0.02099	0.02530*
	(0.44)	(1.19)	(1.58)	(1.84)
	[0.95937]	[0.92537]	[0.96749]	[0.92669]
High Risk WHR	-0.00352	0.00254	0.00907	-0.00424
	(-0.28)	(0.19)	(0.98)	(-0.31)
	[0.96122]	[0.93097]	[0.97006]	[0.92257]
Number of Applications	25	51	21	58
Sample Size	1083	1072	1169	1214

Coefficients are marginal effects. z-statistics in parentheses. Percent of applicants correctly predicted in brackets. $^*p < 0.10$, $^{**}p < 0.05$, and $^{***}p < 0.01$. The models also include education, age at exam, age at exam squared, marital status, family income-to-poverty ratio, and family income category.

Table 5. Social Security Disability Insurance Application Probits for Non-Hispanic Black Persons Ages 21 to 48, with Family Income

	Men		Women	
	Application for DI within:		Application for DI within:	
Measure of Fatness:	5 years	10 years	5 years	10 years
Total Body Fat (w/ Fat Free Mass)	0.00019	-0.00080	-0.00019	-0.00046
	(0.15)	(-0.53)	(-0.29)	(-0.53)
	[0.91961]	[0.84322]	[0.92334]	[0.86871]
Fat Free Mass (w/ Total Body Fat)	0.00026	0.00206	0.00145	0.00208
	(0.28)	(1.49)	(0.98)	(1.12)
	[0.91961]	[0.84322]	[0.92334]	[0.86871]
Percent Body Fat (BIA)	0.00003	-0.00081	0.00056	0.00016
	(0.022)	(-0.46)	(0.85)	(0.17)
	[0.92157]	[0.85729]	[0.92923]	[0.86957]
Percent Body Fat (skinfold)	0.00043	0.00022	0.00037	0.00020
	(0.65)	(0.23)	(0.82)	(0.34)
	[0.91765]	[0.84623]	[0.92671]	[0.86957]
Percent Fat Free Mass	-0.00003	0.00081	-0.00056	-0.00016
	(-0.022)	(0.46)	(-0.85)	(-0.17)
	[0.92157]	[0.85930]	[0.92755]	[0.87127]
Body Mass Index (measured)	0.00059	0.00115	0.00104	0.00117
	(0.51)	(0.76)	(1.28)	(0.91)
	[0.91961]	[0.86131]	[0.92671]	[0.87127]
Body Mass Index (self-reported)	0.00089	0.00087	0.00028	0.00039
	(0.77)	(0.49)	(0.33)	(0.27)
	[0.92157]	[0.86131]	[0.92586]	[0.86957]
Body Mass Index (self-reported, adjusted)	0.00080	0.00117	0.00034	0.00043
	(0.78)	(0.76)	(0.42)	(0.32)
	[0.91961]	[0.86131]	[0.92586]	[0.86957]
Waist Circumference	0.00022	0.00037	0.00056*	0.00063
	(0.40)	(0.54)	(1.75)	(1.21)
	[0.92157]	[0.86332]	[0.92923]	[0.86957]
Waist-to-Hip Ratio	-0.00162	-0.05953	0.11745*	0.12412
	(-0.012)	(-0.35)	(1.90)	(1.26)
	[0.92157]	[0.85729]	[0.92839]	[0.86786]
Obese by PBF (BIA)	0.01323	0.01488	-0.00409	-0.01551
	(0.80)	(0.61)	(-0.29)	(-0.90)
	[0.91373]	[0.83819]	[0.93092]	[0.86957]
Obese by PBF (skinfold)	0.00957	0.01171	-0.00350	0.00121
	(0.50)	(0.43)	(-0.26)	(0.072)
	[0.90882]	[0.83618]	[0.92586]	[0.86957]
Obese by BMI (measured)	0.01063	0.01608	0.02619*	0.02982
	(0.61)	(0.66)	(1.74)	(1.53)
	[0.91471]	[0.84121]	[0.92502]	[0.86701]
Obese by BMI (self-reported)	0.01419	0.03089	0.01227	0.01375
	(0.71)	(0.98)	(0.82)	(0.65)
	[0.91176]	[0.83819]	[0.92334]	[0.86701]
Obese by BMI (self-reported, adjusted)	0.00777	0.02993	0.02275*	0.01794
	(0.41)	(1.00)	(1.73)	(0.92)
	[0.91176]	[0.84422]	[0.92671]	[0.86616]
High Risk WC	0.01015	0.01999	0.02095**	0.03030*
	(0.51)	(0.69)	(2.20)	(1.91)
	[0.91275]	[0.84121]	[0.92502]	[0.87042]
High Risk WHR	0.01243	0.00872	0.00812	0.00921
	(0.59)	(0.37)	(0.55)	(0.44)
	[0.92059]	[0.84322]	[0.92755]	[0.86957]
Number of Applications	69	147	70	161
Sample Size	1026	1001	1187	1173

Coefficients are marginal effects. z-statistics in parentheses. Percent of applicants correctly predicted in brackets. *$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$. The models also include education, age at exam, age at exam squared, marital status, family income-to-poverty ratio, and family income category.