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Body composition and wages

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ABSTRACT

This paper examines the relationship between body composition and wages in the United States. We develop measures of body composition – body fat (BF) and fat-free mass (FFM) – using data on bioelectrical impedance analysis (BIA) that are available in the National Health and Nutrition Examination Survey III and estimate wage models for respondents in the National Longitudinal Survey of Youth 1979. Previous research uses body size or BMI as measures of obesity despite a growing concern that they do not distinguish between body fat and fat-free body mass or adequately control for non-homogeneity inside the human body. Therefore, measures presented in this paper represent a useful alternative to BMI-based proxies of obesity. Our results indicate that BF is associated with decreased wages for both males and females among whites and blacks. We also present evidence suggesting that FFM is associated with increased wages. We show that these results are not the artifacts of unobserved heterogeneity. Finally, our findings are robust to numerous specification checks and to a large number of alternative BIA prediction equations from which the body composition measures are derived.

1. Introduction

Obesity is defined as the presence of excessive body fat (Bjorntorp, 2002; World Health Organization, 1998). A person is classified as obese based on having an excessive level of body fat and it is the excessive levels of fat that have been shown to be associated with a number of adverse health conditions.[1] Therefore, an appropriate measure of obesity should be one that closely measures the level of body fat inside a human's body if one wishes to better understand the potentially harmful effects of obesity on an array of economic and social outcomes, ranging from labor market performance to self-esteem, discrimination, and marriage problems. However, body fat is not directly observable to researchers in most research settings. This is because most individuals do not know how much body fat they possess and methods to measure it typically require clinical instruments that are hardly available or expensive, especially for survey purposes. Most social surveys have instead relied on a number of proxies for measuring obesity. The most commonly used one is the body mass index (BMI), which is calculated as weight in kilograms divided by height in meters squared. One clear advantage of BMI is that it is easily calculated from height and weight, which are readily available in most surveys.

Despite its convenience, BMI is increasingly known as an imperfect surrogate for body fat (Smalley et al., 1990; Gallagher et al., 1996; Romero-Corral et al., 2006). BMI alone explains only 26% of the variations in body fat and a wide a range of conditions exists in which BMI provides misleading information about the levels of body fat (Gallagher et al., 1996; Prentice and Jebb, 2001). In a recent review of the medical literature on the association between BMI and total

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[1] Obesity-related diseases include coronary heart disease, type 2 diabetes, hypertensions, stroke, cancers, and liver and gallbladder diseases (Centers for Disease Control and Prevention, 2007).

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mortality for patients with coronary artery disease, Romero-Corral et al. (2006) found that overweight patients actually had a *better* survival rate and *lower* cardiovascular events than did underweight patients and that obese patients had no increased risk for mortality. Also referred to as "the obesity paradox" (Curtis et al., 2005), an absence of association (or an inverse association) between obesity and mortality in patients with cardiovascular disease has puzzled many medical researchers.[2] Economists who have recently studied the effect of obesity on the labor market outcomes using BMI have also obtained mixed findings.[3]

While BMI is widely used by social scientists, a number of researchers have recently suggested that it might be the inability of BMI to properly distinguish body fat from non-fat body components that is responsible for some of the puzzling findings described above (e.g., Allison et al., 2002; Romero-Corral et al., 2006; Wada, 2007; Burkhauser and Cawley, 2008). Gallagher et al. (1996) and De Lorenzo et al. (2003) suggested that the reliability of BMI for measuring body fat was questionable, and that direct measurements of body fat could provide a significant improvement towards detection and diagnosis of obesity. Furthermore, a consensus report by World Health Organization (1995) warned researchers that BMI must be interpreted carefully to avoid confusing muscularity with obesity.

Direct measurement of body fat has long been available through the analyses of body composition, in which a human body is analytically broken down into its various components (Heyward and Wagner, 2004). One popular approach is the two-compartment model of body fat (BF) and fat-free mass (FFM).[4] In this model, BF is the smaller component consisting mostly of fat tissues, while FFM is the larger component that includes everything else, including muscles and skeletons. One advantage of the two-compartment model is that body fat can be tracked independently from the rest of human body. Using body composition, it has been clinically shown that BF is associated with the ill effects of obesity, while FFM is associated with health and physical fitness (e.g., Heitmann et al., 2000; Allison et al., 2002). Therefore, the marginal effects of BF can be interpreted as the incremental effect of obesity, while the marginal effect of FFM can be considered as the effect of healthy body growth. We argue that a single index like BMI may not capture the complex influence that BF and FFM can exert on the economic and social outcomes. Because the expected effects of BF and FFM are likely to be opposite to each other, they may result in a situation where these opposing effects cancel each other out.

In this paper, we draw data from the National Health and Nutrition Examination Survey 1988–1994 (the NHANES III) and the National Longitudinal Survey of Youth 1979 (NLSY) to estimate the relationship between body composition and the wages. We aim to make three contributions to the literature. First, we develop and propose using body composition measures as an alternative to the BMI-based proxies of obesity. Second, we empirically demonstrate that the calculated body fat is associated with decreases in wages for both males and females among whites and blacks. Third, we show that calculated fat-free mass is associated with increased wages. This result draws attention to the beneficial effect of healthy body growth on wages. Since health is one of the conduits through which body size is hypothesized to influence worker productivity, it should be the healthy body component or the fat-free mass that is associated with worker productivity. This finding also lends support to the nutrition hypothesis, which posits a positive relationship between body size and worker productivity. In his Nobel address, Fogel (1994) stated that increased body size should be associated with increased worker productivity.[5] This assumption of "bigger-is-better" has been questioned in light of the obesity epidemic.[6]

2. Body composition and empirical strategy

Body composition has long been used by nutritionists and physiologists for the purpose of studying nutrition, physical growth, and physical performance (Forbes, 1999). However, the difficulty of obtaining body composition compared to BMI has been an obstacle to its adoption by social science researchers. However, this obstacle has been mitigated by the development of bioelectrical impedance analysis (BIA).[7] In the BIA, the electrical resistance of an individual's body is measured and then converted into BF and FFM using a predetermined prediction equation based on the principle that FFM (with higher water content) registers a lower electrical resistance than BF (National Institutes of Health, 1994). In an NIH conference in 1994, it

[2] Similar associations are also reported by several other studies that examine the association between BMI and mortality in patients without evidence of a cardiovascular disease (Flegal et al., 2005; McGee, 2005).

[3] There is some consensus on a negative association between obesity and wages for white females. However, there is no agreement on the existence of a wage penalty for males or other female population groups. Averett and Korenman (1996), Baum and Ford (2004), and Cawley (2004) have all found a negative association between BMI and wages for white females but not for males or non-white females. For white males, the effect of BMI on wages was found to be non-linear, with overweight workers earning more than underweight or obese workers. Cawley (2004) found that BMI is positively and significantly associated with the wages of black males in some specifications. Baum and Ford (2004) report a weak penalty for male obesity, but the result becomes mixed when the sample is further divided by ethnicity.

[4] The two-compartment models were first proposed by Siri (1961) and Brozek et al. (1963). FFM is sometimes referred to as lean body mass (Heyward and Wagner, 2004). Technically, lean body mass contains a small amount of lipids, while FFM does not any lipids at all. In males, about 97% of lean body mass is FFM, while it is about 92% in females (Lohman, 1992).

[5] See Fogel (1994) and Steckel (1995) for a summary of the nutrition hypothesis.

[6] Behrman and Rosenzweig (2001) explore the possibility that the negative effect of obesity is due to unobserved heterogeneity and not necessarily due to increased body size. Fogel (1994) presents his theory that the beneficial effect of body size is not properly captured by the observed relationship between BMI and mortality, which is U-shaped.

[7] See Kushner et al. (1990), Roubenoff et al. (1995), Sun et al. (2003), and Chumlea et al. (2002) for more on the BIA. Other alternatives to body composition include skinfold thickness, underwater weighting, dual X-ray absorptiometry, magnetic resonance imaging (Heshka et al., 1994; Heymsfield et al., 1998). However, compared to BIA, most of these methods are prohibitively expensive or intrusive for use in large-scale epidemiological studies.