An Estimate of the Effects of Income Inequality, Racial Segregation, and Food Prices on Adult Obesity in the United States [1]

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Abstract: We link individual-level Behavioral Risk Factor Surveillance Survey and various area-level data to estimate whether income inequality, residential segregation, and food prices contributed to the rising prevalence of overweight and obesity among U.S. adults during the past decade. Metropolitan-level income, income inequality, and the relative price of fast-food and grocery store prices are estimated to have decreased the probability of having been overweight or obese. Ethno-racial segregation is estimated to have had the opposite effect, and these area-based socioeconomic factors also contributed to the rise in overweight and obesity indirectly through their impact on diet and exercise behaviors. Implications for the social status comparison and social stress hypotheses are discussed in the conclusion. [Word Count = 113]

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1. The General Rise in Body Mass Index in the United States and Its Consequences

The United States is currently the most overweight and obese nation in the world outside of Oceania (Critser, 2003; Komlos & Baur, 2004; Organization for Economic Cooperation and Development, 2003; Ulijaszek, 2993),[2] and although there are competing methods of measuring body weight (Atkinson, 2002; Gallagher et al., 1997; Garrow & Webster, 1985; Pietrobelli, Wang, & Heymsfield, 1998), the most global metric of obesity is a body mass index (BMI) of more than 30 (kilograms/meters^2), or about 20 percent above "ideal" body weight for a given height.[3] According to the most accurate height and weight data available for the entire United States adult population, the prevalence of obesity in the United States has doubled during the past two decades – from approximately 14 to slightly more than 29 percent (Flegal, Carroll, Kucmarski, & Johnson, 1998; Rashad, Grossman, & Chou, 2005). A similar rate of increase is also observed with the BMI metric when using self-reported anthropometric data – from about 12 to 18 percent during the last decade (Chou, Grossman, & Saffer, 2004; Mokdad et al., 2001; Mokdad et al., 1999).[4]

Despite almost two-thirds of those with perceived body weight problems having reported that they changed their diets or increased physical activity (Serdula et al., 1999), the self-reported height and weight data employed in this study suggests between 20 and 25 percent of adults in the United States are obese (Figure 1) and about 35 percent are overweight (25 kg/m^2 ≥ BMI < 30 kg/m^2).

<<< Figure 1 >>>

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[2] Obesity has risen more rapidly in Australia and the United Kingdom since 1980; however, and evidence suggests the epidemic is spreading to developing countries (Friedrich, 2002).

[3] BMI may also be computed by dividing weight (in pounds) by height (in inches) squared, and multiplying by 704.5. *Underweight* is defined by the National Institutes of Health as BMI<18.5 kg/m^2, *normal weight* as BMI>=18.5 to 24.9 kg/m^2, *overweight* as BMI=25 to 29.9 kg/m^2, and *obese* as BMI>=30 kg/m^2.

[4] This is not to suggest that increases in body weight did not occur earlier in the United States. Between 1864 and 1961, for instance, the BMI of men aged 19 years rose from just under 22 to almost 23, and among men aged 45 years from about 23 to almost 26 (Costa & Steckel, 1995). But during most of the twentieth century body weights were generally lower than recommended to maximize longevity (Fogel, 1994).

There are some well-known demographic group differences in BMI. Higher proportions of men, non-Latino blacks, some Latino populations and other minorities (e.g., American Indians, Alaska Natives, Native Hawaiians), and less educated adults are overweight or obese. Furthermore, although children are estimated to be only one-third as likely to be overweight or obese as adults (Jolliffe, 2004; Troiano & Flegal, 1998), recent evidence suggests that unhealthy childhood weight is a robust predictor of adult obesity (U.S. Preventative Services Task Force, 2003).[5] Perhaps more striking, according to 1993 and 2002 Behavioral Risk Factor Surveillance Survey (BRFSS) data, is the relatively similar increase in obesity rates throughout the entire adult weight distribution which has shifted mean BMI from 25.2 to 26.2 (Flegal & Troiano, 2000; Rose, 1985, 1992; Rose & Day, 1990).[6]

<<< Figure 2 >>>

Obesity's rapid geographic dispersion has been no less alarming than its demographic diffusion. Whereas only four of the states participating in BRFSS are estimated to have had at least 15 percent of their adult populations being obese in 1991, by 2000 all but one state (Colorado) were (Mokdad et al., 2001). Still, there are significant interstate differences. In 2001, for instance, Colorado remained the only state with less than 15 percent of its adult population obese (14.4 percent) and Mississippi had the highest proportion with 25.9 percent (Mokdad et al., 2003).

Some have suggested that if left unchecked, these demographic and geographic trends will soon lead to the entire U.S. adult population being overweight or obese (Foreyt & Goodrick, 1995). Despite such fears, weak evidence that autonomous choice is more important than heteronomous

[5] Subcutaneous fat accumulation is most robust and increasing in early life from about 34 weeks postmenstrual age to about 9 months, and then slackens until about age 6 to 8, at which time it resumes (Bogin, 1999; Tanner, 1978 [1990]).
[6] This claim is less true for children – particularly young children – and to some extent for adolescents and young men, for whom the main BMI increases appear to be in the upper tail of the distribution (Flegal & Troiano, 2000). By comparison for adults, Rashad et al. (2005) report an increase in BMI from 26.4 (1988-1994) to 27.8 (1999-2000).

forces (Stein, 2004), and recent interest in area-based socioeconomic sources of morbidity and mortality among some social epidemiologists (Kawachi & Berkman, 2003; Krieger, Chen, Waterman, Rehkopf, & Subramanian, 2003; Krieger, Chen, Waterman, Rehkopf, & Subramanian, 2005; Link & Phelan, 1995; O'Campo, 2003; Sobal & Stunkard, 1989) and economists (Cawley, 2002; Chou et al., 2004; Cutler, Glaeser, & Shapiro, 2003; Lakdawalla & Philipson, 2002; Rashad & Grossman, 2004; Rashad et al., 2005; Ruhm, 2003), very little work on whether where one resides, relaxes, studies, or works influences body weight has been undertaken. Rather, conventional wisdom and the first U.S. government dietary and exercise recommendations in 25 years (Burros, 2005) suggest that overweight is "an avoidable state, which can be adjusted through diet and behavioral modification" (Philipson, 2001).

Knowing which and how area-based socioeconomic factors are contributing to the overweight-obesity epidemic is especially important for policy formation (Diez-Roux, 2002) given that BMI is positively associated with morbidity and mortality even within relatively healthy ranges of body weight (Willet, 2001)[7] and obesity has recently approached or surpassed smoking as the leading cause of death in the United States. For instance, more than 300,000 or perhaps 400,000 adults are estimated to die annually from obesity-related causes compared to approximately 400,000, 100,000 and 20,000 from tobacco, alcohol and illicit drugs (Allison, Fontaine, Manson, Stevens, & VanItallie, 1999; Flegal, Williamson, Pamuk, & Rosenberg, 2004; Fontaine, Redden, Wang, Westfall, & Allison, 2003; McGinnis & Foege, 1993; Mokdad, Marks, Stroup, & Gerberding, 2004). And because rates of diabetes and gallbladder disease, cardiovascular disease, stroke, disability, anxiety, asthma, depression, hypertension, osteoarthritis (e.g., hip fracture), certain cancers (e.g., colon, kidney, postmenopausal breast, endometrial), and lost productivity due to absenteeism and premature retirement tend to be higher as body weight rises (Cruickshank et al., 2001; Ferraro & Kelley-Moore,

[7] See Flegal et al. (2005) for a recent dissenting and controversial view arguing that overweight may lower mortality.

2003; Friedrich, 2003; Mokdad et al., 2003; Must et al., 1999; Sturm, Ringel, & Andreyeva, 2004), conservative estimates suggest weight-related comorbidities accounted for five to seven percent of annual medical care costs in the 1980s (Colditz, 1992) and 1990s (Colditz, 1999; Thompson & Wolf, 2001; Wolf & Colditz, 1996; Wolf & Colditz, 1998) or $75 billion in 2003 dollars (Finkelstein, Fiebelkorn, & Wang, 2004).[8] Indeed, some scholars contend that these costs (perhaps up to $117 billion annually) are likely to be more substantial than those for any other primary disease for the current generation (Bassett & Perl, 2004; Martin, Robinson, & Moore, 2000).

Evidence that overweight and obese persons experience employment and earnings penalties partly due to employer discrimination has also been mounting (Averett & Korenman, 1996; Baum II & Ford, 2004; Cawley, 2004; Cawley & Danzinger, 2004; Crandell, 1994; Hammermesh & Biddle, 1994; Loh, 1993; Pingitore, Dugoni, Tindale, & Spring, 1994). Unsurprisingly, it has been argued that overweight and obesity reduce overall quality of life (Fontaine & Bartlett, 1998; Fontaine et al., 2003).

While these economic and health impact estimates are a key component of documenting the severity of the overweight-obesity epidemic in the United States, the most important contribution an economic analytical approach offers is a systematic statistical evaluation of the relative influence autonomous and heteronomous causes and their policy implications (Roux & Donaldson, 2004). Drawing upon recent studies in economics and social epidemiology, we develop a behavioral-ecological theoretical framework (section two), build a model of individual body weight that incorporates geographically circumscribed heteronomous socioeconomic factors (section three), and estimate the relative contributions of income inequality, racial segregation, and food prices by linking 1993-2002 BRFSS, 1990 Summary Tape File 3 (STF3) Census, 1992 American Chamber of

[8] Research employing data from the early 1980s placed the lifetime subsidy from others to those with a sedentary lifestyle at $1,900 (Keeler, Manning, Newhouse, Sloss, & Wasserman, 1989).

Commerce Research Association (ACCRA), 1992 Census of Retail Trade, and National Climatic Data Center (NCDC) data.

Although others have investigated the effect of segregation on various health outcomes (Ellen, Mijanovich, & Dillman, 2001; Waitzman & Smith, 1998), of food prices on body weight (Chou et al., 2004), and of income inequality on health after controlling for area-level ethno-racial composition and mean income (Coburn, 2004; Deaton, 2003; Deaton & Lubotsky, 2003; Kawachi & Kennedy, 1997; Lynch et al., 2004; Lynch, Harper, & Davey Smith, 2003; Lynch & Kaplan, 1997; Soobader & LeClere, 1999; Subramanian & Kawachi, 2003a, 2003b; Wen, Browning, & Cagney, 2003), as far as we know this is the first study to estimate simultaneously the relative influence of inequality, segregation, and food prices on BMI in the United States over time using instrumental variables to control for possible selection bias (Cutler & Glaeser, 1997; Newhouse & McClellan, 1998). There are plausible reasons to suspect that the effects of residential segregation (economic or ethno-racial) and income inequality may offset each other (Kawachi, 2002; Kawachi & Kennedy, 2002), but to date only one study of which we are aware has investigated this hypothesis using US mortality data (Lobmayer & Wilkinson, 2002). On one hand, segregation may augment weight by limiting access to relatively healthy foods, raising levels of ethno-racial tension, and discouraging physical activity (social stress), but on the other it may also protect one culturally from unhealthy dietary influences. Income inequality also has a theoretically ambiguous effect on weight gain. Although it may stimulate competition which produces psychological stress and additional weight, it may also encourage weight loss as a means of raising one's social status.

2. A Tripartite Theoretical Framework: Characteristics, Behavior, and Context

Contemporary research on human corpulence may be separated into three broad yet analytically useful conceptual camps spanning a micro-to-macro continuum – individual *characteristics* (also termed "biologic"), individual *behavior* (also labeled "psychological"), and socioeconomic *context* (or environment). This framework allows us to separate those behaviors about which individuals are relatively sentient and therefore over which they may exert some self-control (e.g., eating, exercising, smoking) from those heteronomous physiologic (e.g., metabolic functioning, nutrient oxidation, sympathetic nervous system activity) and contextual (e.g., fast-food price, climate, segregation, inequality) factors about which they are less aware or can do little (Price, 2002; Tataranni & Ravussin, 2002).[9]

Individual Characteristics: Although several hypotheses have been formulated regarding how brain-to-stomach communication occurs via the hypothalamus (Mayer, 1968), the molecules and cell types dedicated to regulating food intake remain only partially known (Chua & Leibel, 2002). For instance, researchers have identified genes that influence the consumption of sweet-tasting carbohydrates and found evidence of a genetic preference for animal fat (Reed, Bachmanov, Beauchamp, Tordoff, & Price, 1997). However, research on the role of leptin – a hormone that tells the brain the stomach is satisfied – has yielded conflicting and inconclusive results (Trayhurn, Hoggard, Mercer, & Rayner, 1999). Similarly, the most effective weight-reducing drugs presently available (e.g., Xenical or Olistat) have produced only modest effects, even when combined with diet and exercise (O'Connor & Grady, 2003; Tsia & Wadden, 2005).

Most scholars currently attribute 25 to 50 percent of point-in-time body weight variability to biology (Bouchard, 1995; Comuzzie & Allison, 1998; Yanovski & Yanovski, 1999), and from 23 percent (Korkeila, Kaprio, Rissanen, & Koskenvuo, 1995) to 86 percent (Austin et al., 1997; Fabsitz,

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[9] We are not suggesting that these three categories are in fact strictly discontinuous – only conceptually and to varying degrees (Lewontin, 2000; Veblen, 1914 [1941]). Certainly the adverse metabolic effects of consuming high-fructose corn syrup or palm oil, for instance, are relatively unknown and therefore subconscious, but also conditioned on their availability in contemporary processed foods and the pecuniary and non-pecuniary costs of obtaining or avoiding them (Critser, 2003). Nor do we assume that all subconscious processes contributing to weight gain will be captured by what we are terming "characteristics." Even when individuals are educated about the dangers associated with being overweight they often make, according to Tomas Philipson, "an unconscious decision to accept weight gain as a by-product of lower food prices coupled with higher paying, but sedentary, work" (Mitka, 2003).

Sholinsky, & Carmelli, 1994) of weight variance over time within people to genes. Unfortunately, the observable individual characteristics we analyze below (i.e., age, ethno-racial group, and gender) are likely to be quite crude proxies for these genetic differences.

Individual Behavior: An alternative conventional view that individuals who are overweight or obese are at best psycho-pathological, or at worst lazy or sinful, has a lengthier history. From ancient Greece to contemporary America excessive weight has most often been attributed to individual behavior. Consequently, relatively reflexive biologic and heteronomous contextual factors have been overshadowed by what are said to be autonomous reflective individual choices as the main determinants of body weight (Oakes, 2004; Shell, 2002). Such a monomaniacal perspective has resulted in research and treatments that focus primarily on changing individual psychology (e.g., negative affect) or behavior (e.g., poor diet, sedentariness) rather than socio-cultural (e.g., familial or group norms) or economic (e.g., availability of affordable healthy food) factors that may directly or indirectly influence body weight.[10] However, even psychology takes seriously the notion that environmentally-generated stress influences health behaviors (Greeno & Wing, 1994), and in addition to highlighting the failure of individual-level interventions some psychologists argue forcefully for a multilevel, population-based preventative approach for solving the obesity-overweight epidemic (Chesney, Thurston, & Thomas, 2001; Visscher & Seidell, 2001). This perspective does not deny the contributions of genetic inheritance to body composition (Comuzzie & Allison, 1998; Hill & Peters, 1998), but intergenerational differences in socioeconomic status and other factors likely to influence weight that are often unobservable also need to be acknowledged (Sanderson, Emanuel, & Holt, 1995).

[10] Several recent reviews illustrate how economists, psychologists, and sociologists have approached the role of biology, emotion, and rationality in human behavior and intimate possibilities for future consilience (Kahneman, 2003; Link & Phelan, 1995; Massey, 2002; McEwen, 2001; Robson, 2001; Syme, 2004).

Contextual Factors: The finding that neither individual biology nor behavior changes easily or rapidly has led other students of human growth to highlight the stability of our genetic constitution during the past several centuries and to argue that while physiology and psychology clearly influence individual energy intake and expenditure and may help explain weight disparities, they cannot explain population-wide changes in body weight and stature (Fogel & Costa, 1997).

Some of the most compelling early evidence supporting contextual hypotheses of disease and unhealthy weight gain came from epidemiological studies of international migration (Bogin & Loucky, 1997; Kasl & Berkman, 1983; Ravussin, Valencia, Esparza, Bennett, & Schulz, 1994). Franz Boas, for example, showed that Italian and Jewish migrants to the United States were significantly larger than their parents (Boas, 1912). Similarly, Japanese migrants to the United States following World War II experienced rapid increases in the level of coronary disease that were positively associated with geographic and cultural distance from Japan (Marmot & Syme, 1976).[11] The basic message is that humans are evolutionarily predisposed toward consuming and storing energy in relatively food-scarce environments, and when the environment becomes more conducive to energy intake, or dissuasive of energy expenditure, weight rises (Nabhan, 2004). But even if "biology permits obesity . . ." and "the environment causes obesity" (Horgen & Brownell, 2002), which contextual factors are potentially obesogenic in the United States remains almost entirely unexplored.[12]

Overweight-obesity research that has considered heteronomous factors has focused either on economic (e.g., poverty, income inequality, unemployment, food prices) or physical (e.g., sidewalk safety, suburban residence) aspects measured at the state level. One of the first econometric

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[11] Considerable subsequent research has provided similar evidence employing data from various immigrant sending and receiving nations (Bhatnagar et al., 1995; Jasso, 2003; Marmot, Adelstein, & Bulusu, 1984; Ravussin et al., 1994; Wandel, 1993; Ziegler et al., 1996; Zigler et al., 1996).

[12] "Obesogenic" (and its opposite, "leptogenic") are relatively new adjectives and refer to conditions that foster excessive weight gain or weight loss.

explorations of factors contributing to mortality in the United States in 1960 found contextual-level factors (e.g., income, education, cigarette smoking) to be more important than medical care. Of particular interest here, the authors hypothesized that the estimated *positive* income-mortality relationship was due to unfavorable diet and exercise (behavior) as well as (psychological) stress – which may have mitigated the benefits of medical care (Auster, Levenson, & Saracheck, 1969). More recently, several studies have emphasized area-based *stressors* (as opposed to individual-level *stress*) that may adversely affect various health outcomes. The underlying argument is that contextual factors such as poverty, income inequality, crime, and residential segregation promote the release of various hormones likely to augment weight (i.e., adrenaline, nuradrenuline, cortisol), and increased abdominal weight (Bjorntorp, 1991, 1996; Brunner, 1997; Brunner & Marmot, 1999; Bujalska, Kumar, & Stewart, 1997; Hautanen, Raikkonen, & Adlercreutz, 1997; Jayo, Shively, Kaplan, & Manuck, 1993; Marin & Bjorntorp, 1993; Pasquali et al., 1996; Pedersen, Jonler, & Richelsen, 1994; Rebuffe-Scrive, Bronnegard, Nilsson, Gustafsson, & Bjorntorp, 1990; Shively & Clarkson, 1988).[13] The biological plausibility of whether infrastructural and socioeconomic conditions of one's neighborhood or the larger geographic area independently influence the probability or prevalence of unhealthy weight through physiologic or behavioral pathways is, with few exceptions and to repeat, largely an untested hypothesis. At present, even the empirical link between what are perceived to be stressful environments and measured stress is purely speculative (Massey, 2004).

Further complicating matters, studies that have investigated the effects of income inequality on weight have yielded conflicting results. These contradictions reflect a number of factors, including differences in the outcome variables, age categories, and geographic units of analysis (i.e. state, metropolitan areas, census tracts). For instance, using 1992 cross-sectional American Cancer Society

[13] Although one recent study using data from Kansas detects a positive relationship between community participation (perhaps one proxy for lower environmental stress) and physical activity, no such relationship was found with obesity (Greiner, Li, Kawachi, Hunt, & Ahluwalia, 2004).

Nutrition Survey and 1990 Census data Khan and associates (1998) report that state-level income inequality independently augmented abdominal weight among relatively well-educated non-Latino white men aged 50 to 64 (but not women) residing in 21 states. Diez-Roux et al. (2000), conversely, use 1990 BRFSS and Census data for 44 states and also find that inequality was positively associated with sedentariness and body weight, but only among women and especially for those at the bottom of the income distribution. Other studies have likewise identified larger inequality effects on women's weight by metropolitan area (Zhang & Wang, 2004), and among Black women (Robert & Reither, 2004).

While it generally appears from these cross-sectional and small-sample studies that state-level income inequality may have adversely affected adult male and female weight net of observable individual characteristics and behaviors during the 1990s, inequality is only one area-based factor that may influence BMI, and research using longer-term data may be instructive. Several newer longitudinal studies by economists focus on the relationship between BMI trends and various economic conditions – including unemployment, technology, and food prices. Most of these studies emphasize how the changing value of time is altered by food production technology and has augmented net energy balance, and thus overweight and obesity, since the 1970s (Hammermesh, 2006). While falling food prices due to improved technology are usually linked to increased caloric intake and less energy expenditure in the form of at home food preparation,[14] new technologies are also sometimes associated with decreased physical activity resulting from unemployment.

Using average unemployment rates from the Bureau of Labor Statistics (BLS) and 1987 to 1995 BRFSS data, Ruhm (2000) estimates that although a stronger economy positively affects most health outcomes, it augments obesity partly by stimulating unhealthy diet and exercise behaviors.

[14] "Food at Home Prices," or what are more commonly known as grocery store prices, are considered a supply-side factor because food purchased in a grocery store (unlike that purchased in a restaurant) requires relatively more effort to obtain, prepare and serve.

In contrast, Cutler and associates (2003) provide descriptive evidence intimating that adult physical activity has changed very little over the past three decades in the United States and some combination of rising caloric intake, nutrient composition, and meal frequency – resulting from more efficient food preparation and preservation technologies – are the main culprits in the American obesity epidemic. In another study, Lakdawalla and Philipson (2002) estimate that approximately 40 percent of the 1981-1994 rise in BMI is attributable to improved agricultural technologies and associated declining metropolitan-area food prices, and some 60 percent to declining physical activity resulting from technological advances reducing home and work effort. Although this study controls for unmeasured time effects, it unfortunately fails to do so for unmeasured area effects shown by others to be potentially significant (e.g., inequality, economic growth).[15] Similarly, Cawley (2002) estimates that falling regional grocery store food prices augmented weight among young adults between 1981 and 1998 in the United States. And Rashas and Grossman (2004) suggest that up to 66 percent of the increase in obesity over the last twenty years emanates from eating out more often (mainly at fast food restaurants) and another 20 percent is a consequence of higher cigarette prices.

The availability and favorable price of easily digested processed foods (e.g., potatoes, white bread or rice, pasta) compared to those that are unprocessed and digested less rapidly (e.g., whole grains, beans, most fruits and vegetables) provides an example where both autonomous and heteronomous forces influence weight. Between 1972 and 1999 the per capita number of fast-food restaurants doubled in the United States (Chou et al., 2004). The physiologic effect according to one hypothesis is simply that foods that are digested faster accelerate the production of blood sugar (glucose) and subsequently a hormone (insulin), which delivers glucose to muscles but then promptly stimulates more hunger (Willet, 2001). One perhaps uncomfortable implication of these various studies is that

[15] Other studies have also emphasized the "declining work effort" hypothesis (Philipson, 2001; Philipson & Posner, 1999).

there are important trade-offs between some social goals (e.g., lower calorie prices, higher nicotine prices, greater female labor force participation) and others (e.g., less overweight and obese persons).

A divergent yet complementary strand of research mainly pursued by epidemiologists and urban planners investigates how the built or physical environment (or the perception of it) influences BMI. These studies contend that opportunities for exercise at work and home, such as local parks or recreation facilities, and safe neighborhoods with sidewalks or walking trails, are likely to be associated with lower rate of obesity or overweight among those who have access to these options.[16] For instance, Catline et al. (2003) use cross-sectional data obtained from almost 2,400 interviewees in Missouri in 1999-2000 and find that negative perceptions of one's self-defined "community or neighborhood" and the absence of outdoor exercise facilities, sidewalks and shoulders had a positive effect on the probability of being overweight or obese. Conversely, workplace policies such as permitting time for physical activity or the availability of exercise facilities were not found to be negatively associated with excessive weight.

Similar concerns about the effect of the built environment on obesity and other health outcomes have been echoed in the growing literature on urban sprawl and its consequence. For example, Ewing and colleagues (2003; McCann & Ewing, 2003) employ pooled 1998-2000 BRFSS and various other data and suggest that urban sprawl had a small significant negative association with walking, and positive association with obesity and hypertension, across 448 counties in the United States after controlling for various demographic and behavioral covariates.

It is clear that the etiology of overweight and obesity is not a new area of research, and that cause is likely to be both multifactorial and multilevel (Weinsier, Hunter, Heini, Goran, & Sell, 1998). Autonomous eating and exercise behaviors rather than heteronomous genetic and

[16] To date only one study of which we are aware by economists has investigated how neighborhood context influences body weight among adults (Kling, Liebman, & Katz, 2005). There are several good summaries of this Moving to Opportunity research (Goering, 2003; Shroder, 2001) .

socioeconomic factors; however, have often been regarded as the primary sources of overweight and obesity in the United States (Brownell & Horgen, 2004; Critser, 2003; Nestle, 2002; Shell, 2002). Researchers have nonetheless provided evidence that personal weight-loss efforts are often disappointing, in part because of conflicting official dietary advice (Willet, 2001), misperceptions of one's weight status (Chang & Christakis, 2003), differences in the knowledge of obesity health risk (Kan & Tsai, 2004), the trade-off between certain unhealthy behaviors such as smoking and overeating (Flegal, Troiano, Pamuk, Kucmarski, & Campbell, 1995; Kawachi, Troisi, Rotnitzky, Coakley, & Colditz, 1996), and adverse effects of more efficient food processing and preservation technologies on self-control (Cutler et al., 2003). These limited results of individual weight-loss endeavors, along with almost half a century of evidence indicating that physiologic (e.g., central nervous system, endocrine system), psychologic, and area-based factors influence caloric intake and metabolism (Greeno & Wing, 1994; Mayer, 1968), suggest that increasing BMI emanates from the interaction of genes, behaviors, and environment, and that one ought to examine how contexts differ or have changed to alter energy-enhancing behaviors (Hill & Peters, 1998).

Some attribute the sluggish shift of attention toward contextual factors to relatively fixed cultural conventions placing fault on overweight individuals and to public health institutions that have historically focused on infectious rather than chronic disease (Horgen & Brownell, 2002). Whatever the relative influence of autonomous and heteronomous factors, aversion to multi-causal approaches is understandable when weight is culturally construed primarily as individual net caloric balance (Mayer, 1968).[17] Below we offer a behavioral-ecological model that permits us to estimate how various metropolitan-level climatic and socioeconomic factors influenced individual weight-related behaviors and weight outcomes during the past decade in the United States.

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[17] One calorie is about the amount of energy a 150-pound person burns each minute while sleeping or, more technically, the amount of heat needed to raise the temperature of a liter of water from 14.5 to 15.5 degrees Celsius (Willet, 2001). One pound is equal to 3,500 calories.

3. Data and Empirical Analysis

Data: The primary data employed in this study are from the Behavioral Risk Factor Surveillance Survey (BRFSS). The BRFSS was first administered in 1984 by the National Center for Chronic Disease Prevention and Health Promotion of the Centers for Disease Control and Prevention (CDC) for 15 states. The main objective of the BRFSS monthly telephone interviews is to collect data on preventative health efforts (e.g., exercise, fruit and vegetable consumption, medical care, seatbelt use) and risky behaviors (e.g., alcohol consumption, smoking) that are associated with the nation's top ten adult diseases and injuries in an effort to provide information that may help reduce these. Specifically, data for one adult is collected from each randomly selected household, and in addition to self-reported height and weight and various health behaviors, information about conventional demographic characteristics is obtained. All states (and the District of Columbia) are represented in the BRFSS, and although county-level data existed for most states by 1993 this was not the case for Wyoming, Rhode Island and Washington, D.C. until 1996.[18] Data at the level of Metropolitan Statistical Area (MSA) became available for the first time in some states in 1998.[19]

A second source of data is the U.S. Census Bureau's 1990 Summary Tape File 3 (STF3), which we use to compute four contextual variables (i.e., income inequality, percent non-Latino black, mean household income, and ethno-racial residential segregation) by MSA as defined by the Office of Management and Budget's (OMB) December 2003 "core based statistical area" (CBSA) specification

[18] BRFSS data for Wyoming are unavailable for 1993, and Rhode Island data are not available from the CDC for 1994 because the state decided to collect them during a six-month, rather than the 12-month, period recommended by the CDC. Data for Washington, D.C. were not collected in 1995. Although we were able to obtain the 1994 Rhode Island data directly from the state, we exclude them from the analysis below for the same reason the CDC does not offer them publicly.

[19] MSA identifiers were only included in the BRFSS data if at least 500 interviews were obtained, and within MSAs, only counties for which sufficient data were collected to permit weighting (at least 50 interviews) were included. In the 2002 Atlanta data, for instance, only three of 28 counties are included due to insufficient sample sizes according to Michele Sussman Walsh of the CDC. Others (Ewing et al., 2003) have employed the 1998-2000 data at the county and MSA level to investigate the relationship between sprawl and obesity.

(Frey, 2005; Mackun, 2005).[20] The CBSA specifications define each metropolitan area neatly by county boundaries and thus eliminate difficulties involved in trying to distinguish discrete metropolitan areas in the past (e.g., the Boston MSA was defined by parts of census tracts, counties, and cities before 2003) as well as permit analyses in which the BRFSS and other data may be linked by MSA for the entire nation over time.[21] As is explained in more detail below, we also employ restaurant wage, minimum wage, and single-family housing price data from the 1990 Public Use Microdata Samples (PUMS) of the U.S. Census Bureau – as well as two public finance characteristics of metropolitan areas (the number of municipal and township governments and the share of local revenue that comes from intergovernmental transfers) from the 1962 Census of Government data following Cutler and Gleaser (1997) – to compute instrumental variables (IVs) for our two food price variables and one ethno-racial segregation variable. Theoretically, metropolitan wages and housing prices are likely to be correlated with the price of food, but not systematically with body weight. Similarly, the number of local governments and the proportion of their revenues emanating from outside government sources are likely to be associated with residential segregation but not with the residuals of the second stage regression of body weight.[22]

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[20] Overall there are 949 CBSAs (13 in Puerto Rico), 369 metropolitan statistical areas (8 in Puerto Rico), and 580 micropolitan statistical areas (5 in Puerto Rico) defined in the United States and its territories by 3,233 counties (92 in Puerto Rico and the Virgin Islands). In the continental United States there are 936 CBSAs (361 metropolitan and 575 micropolitan areas) defined by 3,141 counties.

[21] There are two county definitions that have changed since 1990 that required some attention. First, Clifton Forge City became a part of Alleghany County in Virginia and is defined simply as census tract 701. Because this space is relatively small, has a small population, and is completely enveloped by Alleghany County, we ignore this change. Second, Broomfield County, Colorado was created from census tracts and parts of census tracts from four surrounding counties. Because census tracts changed between 1990 and 2000, we define Broomfield County crudely according to the census tract outline maps located at http://ftp2.census.gov/geo/maps/trt1990/st08_Colorado/. Specifically, we define the county as census tracts 85.13, 85.15, 85.16, and 85.17 in Adams County, tracts 131.02-131.05 in Boulder County, and tracts 98.16 and 98.20 in Jefferson County. We exclude census tract 20 from Weld County because an extremely small area and population of Broomfield City was in this tract.

[22] These assumptions are substantiated below even after controlling for clustering at the metropolitan level, and in addition to the F-statistic (t^2) for each of the five instruments being greater than 10, Hausman test results confirm that the second-stage coefficients produced using 2SLS are significantly different from those generated using OLS. Finally, the model does not appear to be over-identified when we regress the residuals from stage two of 2SLS on the predicted values obtained from the IVs (first) and all other variables (second) in stage two of 2SLS, and analyze the results. We do not, however, examine the strength or weakness of our IVs beyond these methods.

Several additional data sources provide, or permit one to produce, metropolitan-specific information about the pecuniary and non-pecuniary (e.g., acquisition and preparation) costs of calorie consumption. The U.S. Census Bureau's Census of Retail Trade (CRT) provides data on the number of fast-food (SIC 5812/40) and full-service (SIC 5812/10) restaurants by metropolitan area for various years between 1982 and 2000, with the distinction mainly a function of whether an establishment offers limited lines of refreshments and prepared food for proximate or take-home consumption and limited on-premises service (fast-food), or a full menu of prepared food in a setting that seats at least 15 people and has waitpersons (full-service). Fast-food prices include those for a McDonald's Quarter-Pounder with cheese, a thin-crusted cheese pizza at Pizza Hut or Pizza Inn, and fried chicken at KFC's or Church's, but because the distinction between fast-food and full-service food is sometimes ambiguous (e.g., full-service establishments sometimes offer high-caloric inexpensive food) others have grouped them into one variable to capture the effect of the number of restaurants in general on weight outcomes (Chou et al., 2004). In the analysis below we employ only the 1992 CRT data because this is the year that immediately precedes our BRFSS weight data and there is little reason to suspect that food prices rose disproportionately by metropolitan area during the past decade. We also keep these two restaurant types separate because we anticipate that they differentially influence BMI. Specifically, the mean price of a fast-food or full-service restaurant meal by metropolitan area is obtained from 1992 CRT price category data by assigning midpoint prices to meals that fall within certain price ranges (e.g., $3.00 for a meal that is recorded in the "$2.00-$4.99" category) and "reasonable" prices to the low (e.g., $1.50 for the "below $2.00") and high (e.g., $45 for the "$30 or above") open-ended price categories. Following Chou et al. (2004), our grocery store or "food-at-home" price variable is computed from the prices of 13 specific items (i.e., bacon, bananas, bread, eggs, chicken, ground beef, milk, lettuce, margarine, Parmesan cheese, potatoes, steak, and tuna) from households whose heads have a mid-management occupation according to averaged quarterly city-level Cost of Living data from the 1992 American Chamber of Commerce Researchers Association (ACCRA).

Apart from our census-generated metropolitan factors that may alter incentives to engage in physical activity and "eating out," it is plausible that climate also influences the availability and type of outdoor infrastructures and facilities, and thus the probability of expending energy either through athletic exercise or daily activities such as traveling to work, taking children to school, or shopping. City-level climatic (temperature and rainfall) data are obtained from the 1994 County and City Data Books of the U.S. Bureau of the Census – housed at the National Climatic Data Center (NCDC) – and matching largest city to its corresponding MSA is accomplished using the University of Missouri's MABLE/Geocorr2K system.[23] To summarize, the 2003 OMB county-defined metropolitan areas permit us to connect individual-level weight and other data in the BRFSS to income inequality and ethno-racial segregation variables created from the 1990 STF3, food price variables in the CRT and ACCRA data, and climate information in the NCDC data to assess how individual characteristics, individual behavior, and metro context influenced BMI among adults in the United States during the previous decade.[24]

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[23] Climate data are available at *http://fisher.lib.virginia.edu/collections/stats/ccdb/* and the geographic matching software is located at http://mcdc2.missouri.edu/websas/geocorr2k.html.

[24] We employ the 2003 OMB county-defined CBSAs to generate 361 metropolitan statistical areas through which we connect the 1993-2002 BRFSS data to the 1990 STF3, 1992 ACCRA and CRT data, and 1994 NCDC data. In a first step, we find 596,810 (or 58 percent) of all 1,031,426 individuals in the 1993-2003 BRFSS had values for all variables included in our study. Of these, 464,731 (or 78 percent) were located in one of 316 (or 88 percent) of our 361 metropolitan statistical areas – 481 persons resided in counties used to define a metro area but that were not included in the BRFSS survey, and 132,079 resided in non-metro counties that were in the BRFSS. In a second step, we matched individuals remaining in our BRFSS data to two variables computed from the 1962 U.S. Census of Governments data that are used as instruments for residential segregation (the number of municipal governments and the percent of municipal government revenue that is transferred from other governments by metro area); a third variable obtained from the U.S. Bureau of Labor Statistics (state-level minimum wage) and two others (mean hourly wage of restaurant workers and mean value of a single family household) from the 1990 PUMS that are employed as instruments for food prices. When matching with the U.S. Census of Governments' variables we lose two metro areas (Washington D.C. and Chesapeake City, VA) and the 18,542 individuals within these, resulting in 446,189 (or 96 percent) of the former 464,731 individuals. When merging the resulting sample with the three BLS and PUMS variables used as food price instruments, 360,889 (or 81 percent) of 446,189 remained. Although no observations were lost when merging with median household income computed from the 1990 STF3 data in a third step, in a fourth step that merged with the restaurant and grocery food data in the 1992 CRT and ACCRA data the resulting sample is 276,902 (or 77 percent of the previous 360,889 sample). A final merge was performed with the climate variables obtained from the 1994 NCDC data, and 274,007

Our reason for selecting metropolitan area rather than a smaller (e.g., census tract, county) or larger (e.g., state, region) geography extends beyond the analytical usefulness of linking various data that have not been used to analyze obesity in the United States previously. Indeed, the data could be connected at the state or county level also. But because the probability of being overweight and obese is a function of individual behavior, ideally we would like to analyze changes in weight within a geographic space that incorporates a large proportion of the entire population and wherein people are integrated economically and socially. Metropolitan area, formally defined as "containing a recognized population nucleus and adjacent communities that have a high degree of integration with that nucleus" (U.S. Office of Management and Budget, 2000) is arguably best suited for this purpose given that populations interact socioeconomically more at this geographic level compared to county or state levels.[25] Earlier studies have rightly claimed, for instance, that an ecological area of an entire state is "unusually large" for purposes of investigating how residential context may influence weight outcomes (Kahn et al., 1998), and that interpersonal contact potentially influencing eating and exercise patterns are "certainly more likely across smaller areas" (Chang & Christakis, 2005). Unsurprisingly, the number of recent investigations that narrow the geographic scope to the metropolitan level and proceed with either cross-sectional or pooled data (Chang & Christakis, 2005; Ewing et al., 2003) or longitudinal data (Lakdawalla & Philipson, 2002) is on the rise.

Model: We build directly on a behavioral model of body weight (Chou, Grossman, & Saffer, 2002; Chou et al., 2004) using standard economic tools and assuming that overweight and obesity reflect other more fundamental goals in the context of a household production function model of consumer behavior (Becker, 1965) that may be influenced by contextual factors. Our main

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individuals in 136 metropolitan areas remained. Thus, our final matched sample represents 27 percent of all individual adults in the unmatched 1993-2002 BRFSS data and 38 percent of the original 361 OMB-defined metropolitan areas.

[25] Populations within most states cluster in multiple metropolitan areas, for instance, and counties are demographically homogenous compared to metropolitan areas. More important for our purposes, however, metropolitan areas represent an area defined by travel patterns and economic activity rather than arbitrary political boundaries.

contribution is that we control for climate and include several metro-level socioeconomic factors (income inequality, median household income, ethno-racial minority residential segregation), which in addition to food prices, may have both subconscious physiological (direct) and sentient behavioral (indirect) influences on weight (Cawley, 2002; Chou et al., 2004; Cutler et al., 2003; Lakdawalla & Philipson, 2002), as well as labor market variables (Ruhm, 2000, 2003) that have been employed in recent longitudinal multi-level research. Others (Catlin et al., 2003; Chang & Christakis, 2005; Diez-Roux et al., 2000; Ewing et al., 2003; Kahn et al., 1998; Ramsey & Glenn, 2002; Robert & Reither, 2004) have estimated the body weight effects of some of the area-level factors we include in our model – but only employ one or relatively few years of cross-sectional data – and none simultaneously considers climatic, economic, residential segregation, and food price conditions.

At the physiologic level, post-puberty primate body weight is a cumulative function of caloric intake minus caloric expenditure that varies positively with age at a decreasing rate until about age 55, at which time weight begins to decline (Tanner, 1978 [1990]). In addition to age, other exogenous physiologic characteristics such as gender and ethno-racial group uniquely influence weight through food intake and metabolic functioning. Thus, because recent evidence suggests that the entire distribution of body weight has shifted in the United States and dichotomous variables constructed from continuous variables may conceal policy-relevant information about this measure of well-being (Joliffe, 2004), we regress one continuous (BMI) and two dichotomous (OVERWEIGHT and OBESE) variables on AGE, FEMALE, BLACK, LATINO, and OTHER non-white to control for the influence of biology on height-adjusted weight. Table 1 defines and provides the means and standard deviations for these individual characteristics and all other variables used in our analysis.

<<< Table 1 >>>

Though this vector of individual phenotypic variables may correlate with genotypic traits that are associated with excess energy balance, the behavioral-contextual model employed here offers a wider explanatory framework because it recognizes that consumers combine purchased goods and services with employment and leisure time activities to produce more fundamental outcomes such as appearance, health, tasty food, and entertainment that enter their ulterior utility function – and that such behaviors may be influenced by area-based heteronomous socioeconomic factors.

Controlling for age, sex, and ethno-racial group – calories consumed in a given time period will also be a function of various behaviors and their outcomes such as hours worked outside the home, household income, [26] educational attainment, martial status, diet, exercise, and smoking (Chou et al., 2002). Heteronomous factors likely to influence some of these behaviors, and thus caloric intake, include food prices and socioeconomic context. Energy expenditure is a function of calories lost while at work, while doing chores at home, and while engaging in leisure activities. The impact of one's occupation on caloric loss necessarily depends on the physical strenuousness of the work undertaken (Lakdawalla & Philipson, 2002) as well as the number of hours worked. Working more hours will theoretically raise the value of one's time and result in substituting market goods and services for household chores and leisure activities, and a number of other factors (e.g., household income, educational attainment, marital status) will likewise influence energy expenditure (Chou et al., 2002).

Metropolitan context may also directly affect weight through one of several "biologically plausible" pathways. Context-induced stress such as that produced by socioeconomic competition or inequality, for instance, may augment weight by altering neuroendocrine (e.g., the hypothalamic-

[26] Household incomes are converted into 1993 dollars using urban consumer price data obtained from the U.S. Department of Labor's Bureau of Labor Statistics website located at *http://data.bls.gov/servlet/SurveyOutputServlet*.

pituitary adrenal) system and metabolic functioning (Brunner, 1997, 2000; Brunner & Marmot, 1999; Diez-Roux et al., 1999; Ellen et al., 2001; Gluck, Geliebter, & Lorance, 2004; Massey, 2004; McEwen & Lasley, 2002; Sapolsky, 2004; Talbott, 2002; Taylor, 2002; Wallace, Wallace, & Rauh, 2003). But the evidence is mixed: some studies find area-based institutional constraints on healthy behavior and lower socioeconomic status (SES) to be correlated with more individual-level obesogenic behavior and heavier body weight (Ellaway, Anderson, & Macintyre, 1997; Holmes et al., 1998; Reidpath, Burns, Garrard, Mahoney, & Townsend, 2002; Sarlio-Lahteenkorva, Silventoinen, & Lahelma, 2004); and others report only weak evidence of a link between proximity to fast-food restaurants and unsafe exercise environments, on one hand, and unhealthy food choices and overweight, on the other (Burdette & Whitaker, 2004; French, Neumark-Sztainer, Fulkerson, & Hannan, 2001; Turrell, Blakely, Patterson, & Oldenburg, 2004).

We compute and employ traditional measures of income inequality (the Gini coefficient), aggregate income (median household income), and ethno-residential segregation (the dissimilarity index), and also include variables for climate and food prices as defined in Table 1.[27] All models are estimated using year dummy variables and clustering by 2003 OMB county-defined CBSAs, thus providing robust (Huber, 1967) standard errors. And in an effort to control for possible endogeneity introduced into ordinary least squares regressions by inclusion of area-level factors which may partly result from individual decisions about where to reside, we employ the logarithm of the number of municipal governments and the percent of municipalities' intergovernmental revenue within each metropolitan area as instrumental variables for metropolitan residential segregation (Cutler &

[27] We also computed a number of other inequality (e.g., 90/50 and 50/10 decile ratios) and segregation (e.g., isolation index, concentrated poverty) variables, but none were as useful for understanding variation in BMI, overweight, or obesity over time as were the more traditional metrics. We would like to thank Christopher Jencks, John Iceland, Nancy Denton, and Paul Jarkowsky for valuable suggestions regarding these various measures. We also computed metropolitan-level variables for residential crowding (Lipman, 2003; Vargos-Ramos, 2003), travel time to work, and mode of transportation – but none of these were useful.

Glaeser, 1997); and state-level minimum wages, the mean wage of restaurant workers, and the mean price of a single-family dwelling by metropolitan area as instruments for food prices.

4. Results

Columns 1a-3b in Table 2 report results from two-stage least squares (2SLS) regressions of body mass index (BMI), the probability of having been overweight (OVERWEIGHT), and the probability of having been obese (OBESE) on individual characteristics and behaviors and metropolitan socioeconomic context among adults residing in metropolitan areas of the United States between 1993 and 2002.[28] We also include dummy variables for survey year to control for unobserved time influences (but do not report their estimated coefficients), and instrumental variables (as explained above) for residential segregation, the ratio of the price of a fast-food meal to that of a meal from a full-service restaurant, and the price index of a bundle of grocery store food.

<<< Table 2 >>>

Specifically, regarding the generation of IVs for residential segregation, although controlling for metropolitan-level clustering increases the standard error (in parentheses below) on the second IV (percent intergovernmental revenue) to 0.415, the same coefficients – which are very similar to those generated by Cutler and Gleaser (1997) using 1990 metropolitan definitions – and the same R^2 are produced when we do not control for clustering:

[28] Although those residing in non-metro areas are excluded from this analysis, fully 93 percent of the U.S. population resided in one of the metropolitan areas defined by the Office of Management and Budget (OMB) in 2003. By comparison, only 80 percent of the U.S. population was residing in the 1990-defined metropolitan areas (Mackun, 2005).

$$\text{Segregation} = \underset{(0.000)}{0.057} \text{ Log(Number of Municipalities)} - \underset{(0.000)}{0.128} \text{ Percent Intergovernmental Revenue}$$

N = 274, 007
R^2 = .386.

Separate regressions of the fast-food restaurant food price[29] and grocery-store food price level variables on our three IVs (state-level minimum wage, mean hurly wage of restaurant workers, and mean price of a single-family dwelling) and controlling for clustering generate the following results:

$$P_{\text{Fast Food}} = \underset{(0.163)}{0.451} \text{ Wage}_{\text{Min}} + \underset{(0.025)}{0.047} \text{ Wage}_{\text{RestaurantWorkers}} - \underset{(0.000)}{0.001} \text{ P}_{\text{Single-Family Dwelling}}$$

N = 274, 007
R^2 = .091

$$P_{\text{Grocery}} = \underset{(0.197)}{-0.519} \text{ Wage}_{\text{Min}} + \underset{(0.021)}{0.025} \text{ Wage}_{\text{RestaurantWorkers}} + \underset{(0.001)}{0.003} \text{ P}_{\text{Single-Family Dwelling}}$$

N = 274, 007
R^2 = .279

Focusing first on individual characteristics in Table 2, we see that across all three weight models age had a positive effect, as did being non-Latino black or Latino compared to being non-Latino white (Chou et al., 2004). We also see that females were less likely to have been overweight or obese, and non-Latino Asian and others had statistically significant lower weights than non-Latino whites. The only somewhat surprising finding here is that males were not only more likely than females to be overweight, but also obese.

Several individual behaviors or the results thereof – years of formal education completed, real household income, having exercised (outside of work) in the previous month, having eaten at least three servings of fruits and vegetables daily, and having smoked cigarettes at the time of the

[29] Results for full-service food price are similar to those for fast-food prices and are available upon request.

interview – had consistent and statistically significant negative effects on BMI and the probability of having been overweight or obese. Two behavioral variables are estimated to have had somewhat ambiguous effects on weight, however. Although being married or employed appears to have positively affected the probability of having been overweight, it had the opposite effect on the probability of having been obese and on BMI in general. Thus, for reasons future research should investigate it appears that the protective influence of marriage and work on adverse weight gain may operate only at extremely unhealthy body masses. We will return to an analysis of whether various metropolitan-level factors influence the two most widely targeted weight-related behaviors (eating and exercise) momentarily, but beforehand we turn to a consideration of whether metropolitan socioeconomic factors independently influenced weight directly.

Contrary to the few recent studies investigating the impact of income inequality on body weight (Diez-Roux et al., 2000; Kahn et al., 1998; Robert & Reither, 2004) but consistent with Chang and Christakis (2005), we find that income inequality reduced BMI as well as the probability of having been overweight or obese during the last decade. This was the case even after controlling for metropolitan-level median household income, which had a beneficial effect on BMI, and for percent non-Latino black – which, similar Subramanian and Kawachi (2003a) and contrary to Deaton and Lubotsky (2003), had none.[30]

We also find evidence that ethno-racial residential segregation augmented BMI and the probability of having been overweight or obese during the previous decade in metropolitan areas of the United States. This is remarkable for two reasons. First, given that we are controlling for a host of individual characteristics and behaviors, income inequality, factors that previous research has suggested may confound the adverse effects of income inequality (ethno-racial composition and

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[30] Percent non-Latino black is included because there has recently been a lively debate about whether ethno-racial composition confounds the influence of inequality on health across state and metropolitan areas in the United States (Deaton & Lubotsky, 2003; Lynch et al., 2003; Subramanian & Kawachi, 2003a).

average income), and climate – one might reasonable expect not to find any segregation effect. Residential segregation, after all, partly reflects income differentials. Thus, second, one might anticipate the inclusion of other area-based socioeconomic factors such as segregation or social capital to rob much of the explanatory power from inequality (Chang & Christakis, 2005; Kawachi, 2002). Apparently; however, segregation and inequality influence BMI differently.

Introduction of the relative price of a fast-food meal vis-à-vis the price of a full-service restaurant meal and our index of grocery store prices for a bundle of food 13 food items; however, eliminates the effects of metro-level average income, inequality, and segregation (columns 1b, 2b, and 3b). Rather than suggesting the metro-level income, inequality, and segregation are unimportant for understanding the overweight-obesity epidemic in the United States, this result intimates that these area-based socioeconomic factors partly influence BMI through the food distribution system. Consistent with other work (Cawley, 2002; Chou et al., 2004; Lakdawalla & Philipson, 2002), Lakdawalla and Philipson (2002), a reduction of one standard deviation (0.528) in the grocery store food price index is associated with a four percentage point increase in the probability of having been obese. Ironically, however, grocery store food prices actually rose between 1993 and 2002 by 22.1 percent according to the Bureau of Economic Analysis.

<<< Table 3 >>>

The final step of our analysis involved estimating whether various metropolitan-level socioeconomic factors had an additional indirect influence on BMI by encouraging or discouraging healthy dietary and exercise behaviors. In other words, we examine the context-mediating effects of eating and exercise on body weight. Results of these analyses are reported in Table 3, where we see that metropolitan average household income and income inequality augmented the probabilities of having exercised and eaten relatively healthily (column 1). Conversely, ethno-racial residential segregation and the relative price of a fast-food meal are estimated to have discouraged exercise and the consumption of fruits and vegetables (column 2).

5. Conclusion

Past research has suggested that the availability and price of food may be an important mediating factor linking area of residence to diet and the probability of being obese (Cummins & Macintyre, 2006; Swinburn, Egger, & Raza, 1999). More generally, it has been argued that although little empirical evidence connecting neighborhood concentration of poverty and violence resulting form inequality and segregation to high allostatic load (stress) exists, it is plausible that various stress-generating area-based socioeconomic factors have contributed to the overweight-obesity epidemic in the United States (Massey, 2004). One survey of 34 studies in developed nations, for instance, reports that those at the lower end of the socioeconomic status hierarchy are more likely to gain weight over time (Ball & Crawford, 2005).

Our finding that ethno-racial residential segregation augmented the probability of being overweight or obese (both directly, and indirectly through eating and exercise) even after controlling for individual characteristics and behaviors supports the social stress hypothesis. The estimated beneficial effect of metro-level average household income on BMI also supports this hypothesis, and that both these factors (income and segregation) are rendered statistically insignificant after including food prices in our model suggests social stress accompanying low metro-level income and high segregation is partly reflected in the food distribution system. In short, geographically differentiated access to affordable healthy food causes stress in human bodies that leads to weight gain.

Our finding that income inequality reduced the probability of being overweight or obese during the past decade in the United States is consistent with Chang and Christakis (2005). The beneficial inequality effect may be attributed to the notion that metropolitan areas with more inequality have more wealthy residents and thus more resources for health-promoting public investments (Daly, Duncan, Kaplan, & Lynch, 1998). Or perhaps inequality fosters status-seeking behavior resulting in lower BMI among higher status residents and weight emulation among lower-status residents. If the former explanation is correct, this finding supports a social stress hypothesis. If the latter explanation is correct, a social status comparison hypothesis is more plausible.

Preventative measures such as the recent dietary U.S. government guidelines emphasizing individual consumption of nine servings of fruits and vegetables daily, less added sugar and saturated or trans fatty acids, and more exercise may have nutritional scientists and health professionals applauding (Foreman, 2005; Lindner, 2005). But these steps are not new in principle and by themselves are very unlikely to slow or reverse the obesity epidemic in light of our estimated direct and indirect effects of metropolitan-level income, income inequality, ethno-racial segregation, and food prices.

References

Allison, D., Fontaine, K., Manson, K., Stevens, J., & VanItallie, T. (1999). Annual Deaths Attributable to Obesity in the United States. *Journal of the American Medical Association, 282*(16), 1530-1538.

Atkinson, R. L. (2002). Medical Evaluation of the Obese Patient. In T. A. Wadden & A. J. Stunkard (Eds.), *Handbook of Obesity Treatment* (pp. 173-185). New York, NY: The Guilford Press.

Auster, R., Levenson, I., & Saracheck, D. (1969). The Production of Health, and Exploratory Study. *The Journal of Human Resources, 4*(4), 411-436.

Austin, M. A., Friedlander, Y., Newman, B., Edwards, K., Mayer-Davis, E. J., & King, M.-C. (1997). Genetic Influences on Changes in Body Mass Index: A Longitudinal Analysis of Women Twins. *Obesity Research, 5*(4), 326-331.

Averett, S., & Korenman, S. (1996). The Economic Reality of the Beauty Myth. *The Journal of Human Resources, 31*(2), 304-330.

Ball, K., & Crawford, D. (2005). Socioeconomic Status and Weight Change in Adults: A Review. *Social Science & Medicine, forthcoming.*

Bassett, M. T., & Perl, S. (2004). Obesity: The Public Health Challenge of Our Time. *American Journal of Public Health, 94*(9), 1477.
Baum II, C. L., & Ford, W. F. (2004). The Wage Effects of Obesity: A Longitudinal Study. *Health Economics, Forthcoming.*
Becker, G. S. (1965). A Theory of the Allocation of Time. *Economic Journal, 75*(299), 493-517.
Bhatnagar, D., Anand, I. S., Durrington, P. N., Patel, D. J., Wander, G. S., Mackness, M. I., Creed, F., Tomenson, B., Chandrashekhar, Y., Winterbotham, M., Britt, R. P., Keil, J., E.,, & Sutton, G. C. (1995). Coronorary Risk Factors in People from the Indian Subcontinent Living in West London and Their Siblings in India. *Lancet, 345*(February 18th), 405-409.
Bjorntorp, P. (1991). Visceral Fat Accumulation: The Missing Link Between Psychosocial Factors and Cardiovacular Disease? *Journal of Internal Medicine, 230*, 195-201.
Bjorntorp, P. (1996). The Regulation of Adipose Tissue Distribution in Humans. *International Journal of Obesity and Related Metobolic Disorders, 20*(291-302).
Boas, F. (1912). Changes in the Bodily Form of Descendents of Immigrants. *American Anthropologist, 14*(3), 530-562.
Bogin, B. (1999). *Patterns of Human Growth (2nd Edition)*. New York, NY: Cambridge University Press.
Bogin, B., & Loucky, J. (1997). Plasticity, Political Economy, and Physical Growth Status of Guatemala Maya Children Living in the United States. *American Journal of Physical Anthropology, 102*, 17-32.
Bouchard, C. (1995). Genetic Influences on Body Weight and Shape. In K. D. Brownell & C. G. Fairburn (Eds.), *Eating Disorders and Obesity: A Comprehensive Handbook* (pp. 21-26). New York, NY: Guilford Press.
Brownell, K. D., & Horgen, K. B. (2004). *Food Fight: The Inside Story of the Food Industry, America's Obesity Crisis, and What We Can Do About It*. New York, NY: McGraw-Hill.
Brunner, E. (1997). Stress and the Biology of Inequality. *British Medical Journal, 314*, 1472-1476.
Brunner, E. (2000). Toward a New Social Biology. In L. B. Berkman & I. Kawachi (Eds.), *Social Epidemiology* (pp. 306-331). New York, NY: Oxford University Press.
Brunner, E., & Marmot, M. (1999). Social Organization, Stress, and Health. In M. Marmot & R. G. Wilkinson (Eds.), *Social Determinants of Health* (pp. 17-43). New York, NY: Oxford University Press.
Bujalska, I. J., Kumar, S., & Stewart, P. M. (1997). Does Central Obesity Reflect "Cushing's Disease of the Omentum?" *Lancet, 349*, 1210-1213.
Burdette, H. L., & Whitaker, R. C. (2004). Neighborhood Playgrounds, Fast Food Restaurants, and Crime: Relationships to Overweight in Low-Income Preschool Children. *Preventative Medicine, 38*, 57-63.
Burros, M. (2005). U.S. Diet Guide Puts Emphasis on Weight Loss. *The New York Times,* pp. A1, A25.
Catlin, T. K., Simoes, E. J., & Brownson, R. C. (2003). Environmental and Policy Factors Associated with Overweight among Adults in Missouri. *American Journal of Health Promotion, 17*(4), 249-258.
Cawley, J. (2002). *Addiction and the Consumption of Calories: Implications for Obesity.*Unpublished manuscript, Cambridge, MA.
Cawley, J. (2004). The Impact of Obesity on Wages. *The Journal of Human Resources, 34*(2), 451-474.
Cawley, J., & Danzinger, S. (2004). *Obesity as a Barrier to the Transition from Welfare to Work*. Cambridge, MA: NBER Working Paper #10508.
Chang, V. W., & Christakis, N. A. (2003). Self-Perception of Weight Appropriateness in the United States. *American Journal of Preventative Medicine, 24*(4), 332-339.

Chang, V. W., & Christakis, N. A. (2005). Inequality and Weight Status. *Social Science & Medicine, forthcoming*.
Chesney, M. A., Thurston, R. C., & Thomas, K. A. (2001). Creating Social and Public Health Environments to Sustain Behavior Change: Lessons from Obesity Research. In N. Schneiderman & M. A. Speers & J. M. Silva & H. Tomes & J. H. Gentry (Eds.), *Integrating Behavioral and Social Sciences with Public Health* (pp. 31-50). Washington, D.C.: American Psychological Association.
Chou, S.-Y., Grossman, M., & Saffer, H. (2002). *An Economic Analysis ofAdult Obesity: Results from the Behavioral Risk Factor Surveillance System*. Cambirdge, MA: NBER Working Paper #9247.
Chou, S.-Y., Grossman, M., & Saffer, H. (2004). An Economic Analysis of Adult Obesity: Results from the Behavioral Risk Factor Surveillance System. *Journal of Health Economics, 23*, 565-587.
Chua, J., Streamson C.,, & Leibel, R. L. (2002). Body Weight Regulation: Neural, Endocrine, and Autocrine MEchanisms. In T. A. Wadden & A. J. Stunkard (Eds.), *Handbook of Obesity Treatment* (pp. 19-41). New York, NY: The Guilford Press.
Coburn, D. (2004). Beyond the Income Inequality Hypothesis: Class, Neo-Liberalism, and Health Inequalities. *Social Science & Medicine, 58*, 41-56.
Colditz, G. (1999). Economic Costs of Obesity and Inactivity. *Medicine and Science in Sports and Excercise, 31*(11), S663-S667.
Colditz, G. A. (1992). Economic Costs of Obesity. *American Journal of Clinical Nutrition, 55*, 503S-507S.
Comuzzie, A. G., & Allison, D. B. (1998). The Search for Human Obesity Genes. *Science, 280*, 1374-1377.
Costa, D. L., & Steckel, R. H. (1995). *Long-Run Trends in Health, Welfare, and Economic Growth in the United States*. Cambridge, MA: NBER Working Paper #76.
Crandell, C. S. (1994). Prejudice Against Fat People: Ideology and Self-Interest. *Journal of Personality and Social Psychology, 66*(5), 882-894.
Critser, G. (2003). *Fat Land: How Americans Became the Fattest People in the World*. Boston, MA: Houghton Mifflin Company.
Cruickshank, J. K., Mbanya, J. C., Wilks, R., Balkau, B., McFarlane-Anderson, N., & Forrester, T. (2001). Sick genes, sick individuals or sick populations with chronic disease? The emergence of diabetes and high blood pressure in African-origin populations. *International Journal of Epidemiology, 30*, 111-117.
Cummins, S., & Macintyre, S. (2006). Food Environments and Obesity: Neighborhood or Nation? *International Journal of Epidemiology, 35*, 100-104.
Cutler, D. M., & Glaeser, E. L. (1997). Are Ghettos Good or Bad? *The Quarterly Journal of Economics, 112*(August), 827-872.
Cutler, D. M., Glaeser, E. L., & Shapiro, J. M. (2003). Why Have Americans Become More Obese? *Journal of Economic Perspectives, 17*(3), 92-118.
Daly, M. C., Duncan, G. J., Kaplan, G. A., & Lynch, J. W. (1998). Macro-to-Micro Links in the Relation between Income Inequality and Mortality. *The Milbank Quarterly, 76*(3), 315-339.
Deaton, A. (2003). Health, Inequality, and Economic Development. *Journal of Economic Literature, 41*, 113-158.
Deaton, A., & Lubotsky, D. (2003). Mortality, Inequality and Race in American Cities and States. *Social Science & Medicine, 56*(6), 1139-1153.
Diez-Roux, A. V. (2002). Invited Commentary: Places, People, and Health. *American Journal of Epidemiology, 155*(6), 516-519.
Diez-Roux, A. V., Link, B. G., & Northridge, M. E. (2000). A Multilevel Analysis of Income Inequality and Cardiovascular Disease Risk Factors. *Social Science & Medicine, 50*(5), 673-687.

Diez-Roux, A. V., Nieto, F. J., Caulfield, L., Tyroler, H. A., Watson, R. L., & Szklo, M. (1999). Neighborhood Differences in Diet: The Atherosclerosis Risk in Communities (ARIC) Study. *Journal of Epidemiology and Community Health, 53*(1), 55-63.

Ellaway, A., Anderson, A., & Macintyre, S. (1997). Does Area of Residence Affect Body Size and Shape? *International Journal of Obesity, 21*, 304-308.

Ellen, G. I., Mijanovich, T., & Dillman, K.-N. (2001). Neihgborhood Effects on Health: Exploring the Links and Assessing the Evidence. *Journal of Urban Affairs, 23*(3-4), 391-408.

Ewing, R., Schmid, T., Killingsworth, R., Zlot, A., & Raudenbush, S. W. (2003). Relationship Between Urban Sprawl and Physical Activity, Obesity, and Morbidity. *American Journal of Health Promotion, 18*(1), 47-57.

Fabsitz, R. R., Sholinsky, P., & Carmelli, D. (1994). Genetic Influences on Adult Weight Gain and Maximum Body Mass Index in Male Twins. *American Journal of Epidemiology, 140*(8), 711-720.

Ferraro, K. F., & Kelley-Moore. (2003). Cumulative Disadvantage and Health: Long-Term Consequences of Obesity? *American Sociological Review, 68*(October), 707-729.

Finkelstein, E. A., Fiebelkorn, I. C., & Wang, G. (2004). State-Level Estimates of the Annnual Medical Expenditures Attributable to Obesity. *Obesity Research, 12*(1), 18-24.

Flegal, K. M., Carroll, M. D., Kucmarski, R. J., & Johnson, C. L. (1998). Overweight and Obesity Trends in the United States: Prevalence and Trends, 1960-1994. *International Journal of Obesity Related Metabo . . . 22*, 39-47.

Flegal, K. M., Graubard, B. I., Williamson, D. F., & Gail, M. H. (2005). Excess Deaths Associated with Underweight, Overweight, and Obesity. *Journal of the American Medical Association, 293*(15), 1861-1867.

Flegal, K. M., & Troiano, R. P. (2000). Changes in the Distribution of Body Mass Index of Adults and Children in the US Population. *International Journal of Obesity, 24*, 807-818.

Flegal, K. M., Troiano, R. P., Pamuk, E. R., Kucmarski, R. J., & Campbell, S. M. (1995). The Influence of Smoking Cessation on the Prevalence of Overweight in the United States. *New England Journal of Medicine, 333*(18), 1165-1170.

Flegal, K. M., Williamson, D. F., Pamuk, E. R., & Rosenberg, H. M. (2004). Estimating Deaths Attributable to Obesity in the United States. *American Journal of Public Health, 94*(9), 1486-1489.

Fogel, R. W. (1994). Economic Growth, Population Theory, and Physiology: The Bearing of Long-Term Processes on the Making of Economic Policy. *American Economic Review, 84*(3), 369-395.

Fogel, R. W., & Costa, D. L. (1997). A Theory of Technophysio Evolution, with Some Implications for Forcasting Populations, Health Care Costs, adn Pension Costs. *Demography, 34*, 49-66.

Fontaine, K. R., & Bartlett, S. J. (1998). Estimating Health-Related Quality of Life in Obese Individuals. *Disease Management Health Outcomes, 3*(2), 61-70.

Fontaine, K. R., Redden, D. T., Wang, C., Westfall, A. O., & Allison, D. B. (2003). Years of Life Lost Due to Obesity. *Journal of the American Medical Association, 289*(2), 187-193.

Foreman, J. (2005). One Hour of Exercise Is Easier Than You Think. *The Boston Globe,* pp. C1-C2.

Foreyt, J., & Goodrick, K. (1995). The Ultimate Triumph of Obesity. *Lancet, 346*, 134-135.

French, S. A., Neumark-Sztainer, D., Fulkerson, J. A., & Hannan, P. (2001). Fast Food Restaurant Use among Adolescents: Associations with Nutrient Intake, Food Choices and Behavoiral and Psychosocial Variables. *International Journal of Obesity, 25*, 1823-1833.

Frey, W. H. (2005). *Metro America in the New Century: Metropolitan and Central City Demographic Shifts Since 2000*. Washington, D.C.: The Brookings Institution.

Friedrich, M. J. (2002). Epidemic of Obesity Expands Its Spread to Developing Countries. *Journal of the American Medical Assocition, 287*(11), 1382-1385.

Friedrich, M. J. (2003). Researchers Explore Obesity-Cancer Link. *Journal of the American Medical Association, 290*(21), 2790-2791.
Gallagher, D., Visser, M., Sepulveda, D., Pierson, R. N., Harris, T., & Heymsfield, S. B. (1997). How Useful is Body Mass Index for Comparison of Body Fatness across Age, Sex, and Ethnic Groups? *American Journal of Epidemiology, 145*(1), 82-83.
Garrow, J. S., & Webster, J. (1985). Quetlet's Index (W/H2) as a Measure of Fatness. *International Journal of Obesity, 9*(2), 147-153.
Gluck, M. E., Geliebter, A., & Lorance, M. (2004). Cortisol Stress Response Is Positively Correlated with Central Obesity in Obese Women with Binge Easting Disorder (BED) before and after Cognitive-Behavioral Treatment. *Annals of the New York Academy of Sciences, 1032*(202-207).
Goering, J. (2003). The Impacts of New Neighborhoods on Poor Families: Evaluating the Policy Implications of the Moving to Opportunity Demonstration. *FRBNY Economic Policy Review, June*, 113-140.
Greeno, C. G., & Wing, R. R. (1994). Stress-Induced Eating. *Psychological Bulletin, 115*(3), 444-464.
Greiner, K. A., Li, C., Kawachi, I., Hunt, D. C., & Ahluwalia, J. S. (2004). The Relationships of Social Participation and Community Ratings to Health and Health Behaviors in Areas with High and Low Population Density. *Social Science & Medicine, 59*, 2303-2312.
Hammermesh, D. S. (2006). *Time to Eat: Household Production Under Increasing Income Inequality*. Cambridge, MA: NBER Working Paper No. 12002.
Hammermesh, D. S., & Biddle, J. E. (1994). Beauty and the Labor Market. *American Economic Review, 84*(5), 1174-1194.
Hautanen, A., Raikkonen, K., & Adlercreutz, H. (1997). Associations between Pituitary-Adrenocortical Function and Abdominal Obeisty, Hyperinsulinemia and Dyslipidaemia in Normotensive Males. *Journal of Internal Medicine, 241*, 451-461.
Hill, J. O., & Peters, J. C. (1998). Environmental Contributions to the Obesity Epidemic. *Science, 280*, 1371-1374.
Holmes, M. D., Stampfer, M. J., Wold, A. M., Jones, C. P., Spiegelman, D., Manson, J. E., & Colditz, G. A. (1998). Can Behavioral Risk Factors Explain the Difference in Body Mass Index Between African-American and European-American Women? *Ethnicity and Disease, 8*(Autumn), 331-339.
Horgen, K. B., & Brownell, K. D. (2002). Confronting the Toxic Environment: Environmental and Public Health Actions in a World Crisis. In T. A. Wadden & A. J. Stunkard (Eds.), *Handbook of Obesity Treatment* (pp. 95-106). New York, NY: The Guilford Press.
Huber, P. J. (1967). The Behavoir of Meximum Likelihood Estimates Under Nonstandard Condistions, *Fifth Berkeley Symposium on Mathematical Statistics and Probability* (pp. 221-233). Berkeley, CA: University of California Press.
Jasso, G. (2003). Migration, Human Development, and the Life Course. In J. T. Mortimer & M. J. Shanahan (Eds.), *Handbook of the Life Course* (pp. 331-364). New York, NY: Kluwer Academic/PLenum Publishers.
Jayo, J. M., Shively, C. A., Kaplan, J. R., & Manuck, S. B. (1993). Effects of Exercise and Stress on Body Fat Distribution in Male Cynomolgus Monkeys. *International Journal of Obesity and Related Metobolic Disorders, 17*, 597-604.
Joliffe, D. (2004). Continous and Robust Measures of the Overweight Epidemic: 1971-2000. *Demography, 41*(2), 303-314.
Jolliffe, D. (2004). Extent of Overweight among US Children and Adolescents from 1971 to 2000. *International Journal of Obesity, 28*, 4-9.

Kahn, H. S., Tatham, L. M., Pamuk, E. R., & Heath, C. W. J. (1998). Are Geographic Regions with High Income Inequality Associated with Risk of Abdominal Weight Gain? *Social Science & Medicine, 47*(1), 1-6.

Kahneman, D. (2003). A Psychological Perspective of Economics. *American Economic Review, 93*(2), 162-168.

Kan, K., & Tsai, W.-D. (2004). Obesity and Risk Knowledge. *Journal of Health Economics, ??*(??), ??-??

Kasl, S. V., & Berkman, L. B. (1983). Health Consequences of the Experience of Migration. *Annual Review of Public Health, 4*, 69-90.

Kawachi, I. (2002). Income Inequality and Economic Residential Segregation. *Journal of Epidemiology and Community Health, 56*(3), 165-166.

Kawachi, I., & Berkman, L. B. (Eds.). (2003). *Neighborhoods and Health*. New York, NY: Oxford University Press.

Kawachi, I., & Kennedy, B. P. (1997). The Relationship of Income Inequality to Mortality: Does the Choice of Indicator Matter? *Social Science & Medicine, 45*(7), 1121-1127.

Kawachi, I., & Kennedy, B. P. (2002). *The Health of Nations: Inequality is Harmful to Your Health*. New York, NY: The New Press.

Kawachi, I., Troisi, R. J., Rotnitzky, A. G., Coakley, E. H., & Colditz, G. A. (1996). Can Physical Activity Minimize Weight Gain in Women After Smoking Cessation? *American Journal of Public Health, 86*(7), 999-1004.

Keeler, E. B., Manning, W. G., Newhouse, J. P., Sloss, E. M., & Wasserman, J. M. A. (1989). The External Costs of a Sedentary Lifestyle. *American Journal of Public Health, 79*(8), 975-981.

Kling, J. R., Liebman, J. B., & Katz, L. F. (2005). *Experimental Analysis of Nieghborhood Effects.* Cambridge, MA: NBER.

Komlos, J., & Baur, M. (2004). From the Tallest to (One of) the Fattest: The Enigmatic Fate of the American Population in the 20th Century. *Economics and Human Biology, 2*, 57-74.

Korkeila, M., Kaprio, J., Rissanen, A., & Koskenvuo, M. (1995). Consistency and Change of Body Mass Index and Weight: A Study of 5967 Adult Finnish Twin Pairs. *International Journal of Obesity, 19*, 310-317.

Krieger, N., Chen, J. T., Waterman, P. D., Rehkopf, D. H., & Subramanian, S. V. (2003). Race/Ethnicity, Gender, and Monitoring Socioeconomic Gradients in Health: A Comparison of Area-Based Socioeconomic Measures -- the Public Health Disparities Geocoding Project. *American Journal of Public Health, 93*(10), 1655-1671.

Krieger, N., Chen, J. T., Waterman, P. D., Rehkopf, D. H., & Subramanian, S. V. (2005). Painting a Truer Picture of US Socioeconomic and Racial/Ethnic Health Inequalities: The Public Health Disparities Geocoding Project. *American Journal of Public Health, 95*(2), 312-323.

Lakdawalla, D., & Philipson, T. (2002). *The Growth of Obesity and Technological Change: A Theoretical and Empirical Investigation.* Cambridge, MA: NBER Working Paper 8965.

Lewontin, R. (2000). *The Triple Helix: Gene, Organism, and Environment.* Cambridge, MA: Harvard Univeristy Press.

Lindner, L. (2005). More Guidelines Add Up to Eating Less Food. *The Boston Globe,* pp. C1, C4.

Link, B. G., & Phelan, J. (1995). Social Conditions as Fundamental Casues of Disease. *Journal of Health and Social Behavior, 35*, 80-94.

Lipman, B. J. (2003). *America's Newest Working Families: Cost, Crowding and Conditions for Immigrants*. Washington, D.C.: Center for Housing Policy.

Lobmayer, P., & Wilkinson, R. G. (2002). Inequaity, Residential Segregation by Income, and Mortality in US Cities. *Journal of Epidemiology and Community Health, 56*(3), 183-187.

Loh, E. S. (1993). The Economic Effects of Physical Appearance. *Social Science Quarterly, 74*(2), 420-438.

Lynch, J. W., Davey Smith, G., Harper, S., Hillemeier, M., Ross, N., Kaplan, G. A., & Wolfson, M. (2004). Is Income Inequality a Determinent of Population Health? Part 1: A Systematic Review. *The Milbank Quarterly, 82*(1), 5-99.
Lynch, J. W., Harper, S., & Davey Smith, G. (2003). Commentary: Plugging Leaks and Repelling Boarders - Where to Next for the SS Income Inequality? *International Journal of Epidemiology, 32*, 1029-1036.
Lynch, J. W., & Kaplan, G. A. (1997). Understanding How Inequality in the Distribution of Income Affects Health. *Journal of Health Psychology, 2*(3), 297-314.
Mackun, P. J. (2005). *Population Change in Metropolitan and Micropolitan Statistical Areas: 1990-2003*. Suitland, MD: U.S. Census Bureau Current Population Report (P25-1134).
Marin, P., & Bjorntorp, P. (1993). Endocrine-Metabolic Pattern and Adipose Tissue Distribution. *Hormone Research, 39*(Supplement 3), 81-85.
Marmot, M. G., Adelstein, A. M., & Bulusu, L. (1984). Lessons from the Study of Immigrant Mortality. *Lancet*(June 30th), 1455-1457.
Marmot, M. G., & Syme, S. L. (1976). Acculturation and Coronary Heart Disease in Japanese-Americans. *American Journal of Epidemiology, 104*(3), 225-247.
Martin, L. F., Robinson, A., & Moore, B. J. (2000). Socioeconomic Issues Affecting the Treatment of Obesity in the New Mellennium. *Pharmacoeconomics, 18*(4), 335-353.
Massey, D. S. (2002). A Brief History of Human Society: The Origin and Role of Emotion in Social Life. *American Sociological Review, 67*(February), 1-29.
Massey, D. S. (2004). Segregation and Stratification: A Biosocial Perspective. *Du Bois Review, 1*(1), 7-25.
Mayer, J. (1968). *Overweight: Causes, Cost, and Control*. Englewood Cliffs, NJ: Prentice-Hall, Inc.
McCann, B. A., & Ewing, R. (2003). *Measuring the Helath Effects of Sprawl: A National Analysis of Physical Activity, Obesity and Chronic Disease*. Washington, D.C.: Smart Growth America.
McEwen, B. S. (2001). From Molecules to Mind: Stress, Individual Differences, and the Social Environment. *Annals of the New York Academy of Sciences, 935*, 42-49.
McEwen, B. S., & Lasley, E. N. (2002). *The End of Stress as We Know It*. Washington, D.C.: Joseph Henry Press.
McGinnis, M., & Foege, W. (1993). Actual Causes of Deaths in the United States. *American Journal of Public Health, 270*(18), 2207-2212.
Mitka, M. (2003). Economist Takes Aim at "Big Fat" US Lifestyle. *Journal of the American Medical Association, 289*(1), 33-34.
Mokdad, A. H., Bowman, B. A., Ford, E. S., Vinicor, F., Marks, J. S., & Koplan, J. P. (2001). The Continuing Epidemics of Obesity and Diabetes in the United States. *Journal of the American Medical Association, 286*(10), 1195-1200.
Mokdad, A. H., Ford, E. S., Bowman, B. A., Dietz, W. H., Vinicor, F., Bales, V. H., & Marks, J. S. (2003). Prevalenceof Obesity, Diabetes, and Obesity-Related Health Risk Factors, 2001. *Journal of the American Medical Association, 289*(1), 76-79.
Mokdad, A. H., Marks, J. S., Stroup, D. F., & Gerberding, J. L. (2004). Actual Causes of Death in the United States. *Journal of the American Medical Association, 291*(10), 1238-1245.
Mokdad, A. H., Serdula, M. K., Dietz, W. H., Bowman, B. A., Marks, J. S., & Koplan, J. P. (1999). The Spread of the Obesity Epidemic in the United States, 1991-1998. *Journal of the American Medical Association, 282*(16), 1519-1522.
Must, A., Spadano, J., Coakley, E. H., Field, A. E., Colditz, G., & Dietz, W. H. (1999). The Disease Burden Associated with Overweight and Obesity. *Journal of the American Medical Association, 282*(16), 1523-1529.

Nabhan, G. P. (2004). *Why Some Like It Hot: Food, Genes, and Cultural Diversity*. Washington, D.C.: Island Press.

Nestle, M. (2002). *Food Politics: How the Food Industry Influences Nutrition and Health*. Berkeley, CA: University of California Press.

Newhouse, J. P., & McClellan, M. (1998). Econometrics in Outcomes Research: The Use of Instrumental Variables. *Annual Review of Public Health, 19*, 17-34.

Oakes, M. E. (2004). *Bad Foods: Changng Attitudes about What We Eat*. New Brunswick, NJ: Transaction Publishers.

O'Campo, P. (2003). Invited Commentary: Advancing Theory and Methods for Multilevel Models of Residential Neighborhoods and Health. *American Journal of Epidemiology, 157*(1), 9-13.

O'Connor, A., & Grady, D. (2003). F.D.A. Moves to Let Drug Treat Obese Teenagers. *New York Times,* pp. A27.

Organization for Economic Cooperation and Development. (2003). *Health at a Glance: OECD Indicators 2003*. Retrieved, from the World Wide Web: http://www.oecd.org/document/11/0,2340,en_2649_34487_16502667_1_1_1_37407,00.html

Pasquali, R., Anconetani, B., Chattat, R., Biscotti, M., Spinucci, G., & Casimirri, F. (1996). Hypothalamus-Pituitary-Adrenal Axis Activity and Its Relationship to the Autonomic Nervous System in Women with Visceral and Subcutaneous Obesity: Effects of the Corticotropin-Releasing Factor/Arginine-Vasopressin Test and of Stress. *Metabolism, 45*, 351-356.

Pedersen, S. B., Jonler, M., & Richelsen, B. (1994). Characterization of Regional and Gender Differences in Glucocorticoid Receptors and Lipoprotein Lipase Activity in Human Adipose Tissue. *Journal of Clinical Endocrinology and Metabolism, 78*, 1354-1359.

Philipson, T. (2001). The World-Wide Growth in Obesity: An Economic Research Agenda. *Health Economics, 10*, 1-7.

Philipson, T. J., & Posner, R. A. (1999). *The Long-Run Growth in Obesity as a Function of Technological Change*. Cambridge, MA: NBER Working Paper #7423.

Pietrobelli, A., Wang, Z., & Heymsfield, S. B. (1998). Techniques Use in Measuring Human Body Composition. *Current Opinion in Clinical Nutrition and Metobolic Care, 1*(439-448).

Pingitore, R., Dugoni, B. L., Tindale, R. S., & Spring, B. (1994). Bias Against Overweight Job Applicants in a Simulated Employment Interview. *Journal of Applied Psychology, 79*(6), 909-917.

Price, R. A. (2002). Genetics and Common Obesities: Background, Current Status, Strategies, and Future Prospects. In T. A. Wadden & A. J. Stunkard (Eds.), *Handbook of Obesity Treatment* (pp. 73-94). New York, NY: The Guilford Press.

Ramsey, P. W., & Glenn, L. L. (2002). Obesity and Health Status in Rural, Urban, and Suburban Southern Women. *Southern Medical Journal, 95*(7), 666-671.

Rashad, I., & Grossman, M. (2004). The Economics of Obesity. *The Public Interest, 156*(Summer), 104-112.

Rashad, I., Grossman, M., & Chou, S.-Y. (2005). *The Super Size of America: An Economic Estimation of Body Mass Index and Obesity in Adults*.Unpublished manuscript, Cambridge, MA: NBER Working Paper #11584.

Ravussin, E., Valencia, M. E., Esparza, J., Bennett, P. H., & Schulz, L. O. (1994). Effects of a Traditional Lifestyle on Obesity in Pima Indians. *Diabetes Care, 17*(9), 1067-1074.

Rebuffe-Scrive, M., Bronnegard, M., Nilsson, A., Gustafsson, J. A., & Bjorntorp, P. (1990). Steroid Hormone Receptors in Human Adipose Tissue. *Journal of Clinical Endocrinology and Metabolism, 71*, 1215-1219.

Reed, D. R., Bachmanov, A. A., Beauchamp, G. K., Tordoff, M. G., & Price, R. A. (1997). Heritable Variation in Food Preferences and Their Contrbution to Obesity. *Behavioral Genetics, 27*(4), 373-387.

Reidpath, D. D., Burns, C., Garrard, J., Mahoney, M., & Townsend, M. (2002). An Ecological Study of the Relationship between Social and Environmental Determinants of Obesity. *Health and Place, 8*, 141-145.

Robert, S. A., & Reither, E. N. (2004). A Multilevel Analysis of Race, Community Disadvantage, and Body Mass Index among Adults in the US. *Social Science & Medicine, 59*(12), 2421-2434.

Robson, A. J. (2001). The Biological Basis of Economic Behavior. *Journal of Economic Literature, 34*(March), 11-33.

Rose, G. (1985). Sick Individuals and Sick Populations. *International Journal of Epidemiology, 14*, 32-38.

Rose, G. (1992). *The Strategy of Preventative Medicine*. New York, NY: Oxford University Press.

Rose, G., & Day, S. (1990). Theh Population Mean Predicts the Number of Deviant Individuals. *British Medical Journal, 301*, 1031-1034.

Roux, L., & Donaldson, C. (2004). Economics and Obesity: Costing the Problem or Evaluating Solutions? *Obesity Research, 12*(2), 173-179.

Ruhm, C. J. (2000). Are Recessions Good for Your Health? *Quarterly Journal of Economics, 115*(2), 617-650.

Ruhm, C. J. (2003). *Healthy Living in Hard Times.*Unpublished manuscript, NBER Working Paper Series #9468, Cambridge, MA.

Sanderson, M., Emanuel, I., & Holt, V. (1995). The Intergenerational Relationship between Mother's Birthweight, Infant Birthweight and Infant Mortality in Black and White Mothers. *Paediatric and Perinatal Epidemiology, 9*, 391-405.

Sapolsky, R. M. (2004). *Why Zebras Don't Get Ulcers*. New York, NY: Henry Holt and Company.

Sarlio-Lahteenkorva, S., Silventoinen, K., & Lahelma, E. (2004). Relative Weight and Income at Different Levels of Socioeconomic Status. *American Journal of Public Health, 94*(3), 468-472.

Serdula, M. K., Mokdad, A. H., Williamson, D. F., Galuska, D. A., Mendlein, J. M., & Heath, G. W. (1999). Prevalence of Attempting Weight Loss and Strategies for Controlling Weight. *Journal of the American Medical Association, 282*(14), 1353-1358.

Shell, E. R. (2002). *The Hungry Gene: The Inside Story of the Obesity Industry*. New York, NY: Grove Press.

Shively, C. A., & Clarkson, T. B. (1988). Regional Obesity and Coronary Artery Atherosclerosis in Females: A Non-Human Primate Model. *Acta Medica Scandinavica, 723*(Supplement), 71-78.

Shroder, M. (2001). Moving to Opportunity: An Experiment in Social and Geographic Mobiilty. *Cityscape: A Journal of Policy Development and Research, 5*(2), 57-67.

Sobal, J., & Stunkard, A. J. (1989). Socioeconomic Status and Obesity: A Review of the Literature. *Psychological Bulletin, 105*(2), 260-275.

Soobader, M.-J., & LeClere, F. B. (1999). Aggregation and the Measurement of Income Inequality: Effects on Morbidity. *Social Science & Medicine, 48*, 733-744.

Stein, J. (2004). Adults Acknowledge Weight Issues. *Los Angeles Times,* pp. F4.

Sturm, R., Ringel, J. S., & Andreyeva, T. (2004). Increaasing Obesity Rates and Disability Trends. *Health Affairs, 23*(2), 199-205.

Subramanian, S. V., & Kawachi, I. (2003a). The Association between State Income Inequality and Worse Health Outcomes Is Not Confuonded by Race. *International Journal of Epidemiology, 32*, 1022-1028.

Subramanian, S. V., & Kawachi, I. (2003b). Response: In Defense of the Income Inequality Hypothesis. *International Journal of Epidemiology, 23*, 1037-1040.

Swinburn, B., Egger, G., & Raza, F. (1999). Dissecting Obesogenic Environments: The Development and Application of a Framework for Indentifying and Prioritising Environmental Interventions for Obesity. *Preventative Medicine, 29*, 563-570.
Syme, S. L. (2004). Social Determinants of Health: The Community as an Empowered Partner. *Preventing Chronic Disease: Public Health Research, Practice, and Policy, 1*(1), 1-5.
Talbott, S. (2002). *The Cortisol Connection: Why Stress Makes You Fat and Ruins Your Health -- and What You Can Do about It*. Berkeley, CA: Hunter House Publishers.
Tanner, J. M. (1978 [1990]). *Foetus into Man: Physical Growth from Conception to Maturity*. Cambridge, MA: Harvard University Press.
Tataranni, P. A., & Ravussin, E. (2002). Energy Metabolism and Obesity. In T. A. Wadden & A. J. Stunkard (Eds.), *Handbook of Obesity Treatment* (pp. 42-72). New York, NY: The Guilford Press.
Taylor, S. E. (2002). *The Tending Instinct: How Nurturing is Essential for Who We Are and How We Live*. New York, NY: Times Books.
Thompson, D., & Wolf, A. M. (2001). The Medical-Care Cost Burden of Obesity. *Obesity Reviews, 2*, 189-197.
Trayhurn, P., Hoggard, N., Mercer, J. G., & Rayner, D. V. (1999). Leptin: Fundamental Aspects. *International Journal of Obesity, 23*(Supplement 1), 22-28.
Troiano, R. P., & Flegal, K. M. (1998). Overweight Children and Adolescents: Description, Epidemiology, and Demographics. *Pediatrics, 101*(3), 497-504.
Tsia, A. G., & Wadden, T. A. (2005). Systematic Review: An Evaluation of Major Commercial Weight Loss Programs in the United States. *Annals of Internal Medicine, 142*(1), 56-67.
Turrell, G., Blakely, T., Patterson, C., & Oldenburg, B. (2004). A Multilevel Analysis of Socioeconomic (Small Area) Differences in Household Food Purchasing Behavior. *Journal of Epidemiology and Community Health, 58*, 208-215.
U.S. Office of Management and Budget. (2000). *Standards for Defining Metropolitan and Micropolitan Statistical Areas; Notice*. Washington, D.C.
U.S. Preventative Services Task Force. (2003). *Screening for Obesity in Adults: Recommendations and Rationale*. Retrieved February 20, 2004, from the World Wide Web: www.ahcpr.gov/clinic/uspstfix.htm
Ulijaszek, S. J. (2993). Trends in Body Size, Diet and Food Availabiity in the Cook Islands in the Second Half of the 20th Century. *Economics and Human Biology, 1*, 123-137.
Vargos-Ramos, C. (2003). *Housing Emergency and Overcrowding: Latinos in New York City*. New York: Centro de Estudios Puertorriquenos, Hunter College, CUNY.
Veblen, T. (1914 [1941]). *The Instinct of Workmanship*. New York, NY: W.W. Norton & Company, Inc.
Visscher, T. L. S., & Seidell, J. C. (2001). The Public Health Impact of Obesity. *Annual Review of Public Health, 22*, 355-375.
Waitzman, N. J., & Smith, K. R. (1998). Separate but Lethal: The Effects of Econmic Segregation on Mortality in Metropolitan America. *The Milbank Quarterly, 76*(3), 341-373.
Wallace, D., Wallace, R., & Rauh, V. (2003). Community Stress, Demoralization, and Body Mass Index: Evidence for Social Signal Transduction. *Social Science & Medicine, 56*, 2467-2478.
Wandel, M. (1993). Nutirtion-Related Diseases and Dietary Change among Third World Immigrants in Northern Europe. *Nutrition and Health, 9*(2), 117-133.
Weinsier, R. L., Hunter, G. R., Heini, A. F., Goran, M. I., & Sell, S. M. (1998). The Etiology of Obesity: Relative Contribution of Metabolic Factors, Diet, and Physical Activity. *American Medical Journal, 105*, 145-150.

Wen, M., Browning, C. R., & Cagney, K. A. (2003). Poverty, Affluence, and Income Inequality: Neighborhood Economic Strcuture and Its Implications for Health. *Social Science & Medicine, 57*, 843-860.
Willet, W. C. (2001). *Eat, Drink, and Be Healthy*. New York, NY: Simon & Schuster.
Wolf, A. M., & Colditz, G. A. (1996). Social and Economic Effects of Body Weight in the United States. *American Journal of Clinical Nutrition, 63*(3), 466S-469S.
Wolf, A. M., & Colditz, G. A. (1998). Current Estimatates of the Economic Cost of Obesity in the United States. *Obesity Research, 6*(2), 97-106.
Yanovski, J. A., & Yanovski, S. Z. (1999). Recent Advances in Basic Obesity Research. *Journal of the American Medical Association, 282*(16), 1504-1506.
Zhang, Q., & Wang, Y. (2004). Socioeconomic Inequality of Obesity in the United States: Do Gender, Age, and Ethnicity Matter? *Social Science & Medicine, 58*, 1171-1180.
Ziegler, R. G., Hoover, R. N., Nomura, A. M. Y., West, D. W., Wu, A. H., Pike, M. C., Lake, A. J., Horn-Ross, P. L., Kolonel, L. N., Siiteri, P. K., & Fraumeni Jr., J. (1996). Relative Weight, Weight Change, Height, and Breat Cancer Risk among Asian-American Women. *Journal of the National Cancer Institute, 88*(10), 650-660.
Zigler, R. G., Hoover, R. N., Nomura, A. M. Y., West, D. W., Wu, A. H., Pike, M. C., Lake, A. J., Horn-Ross, P. L., Kolonel, L. N., Siiteri, P. K., & Fraumeni Jr., J. (1996). Relative Weight, Weight Change, Height, and Breat Cancer Risk among Asian-American Women. *Journal of the National Cancer Institute, 88*(10), 650-660.

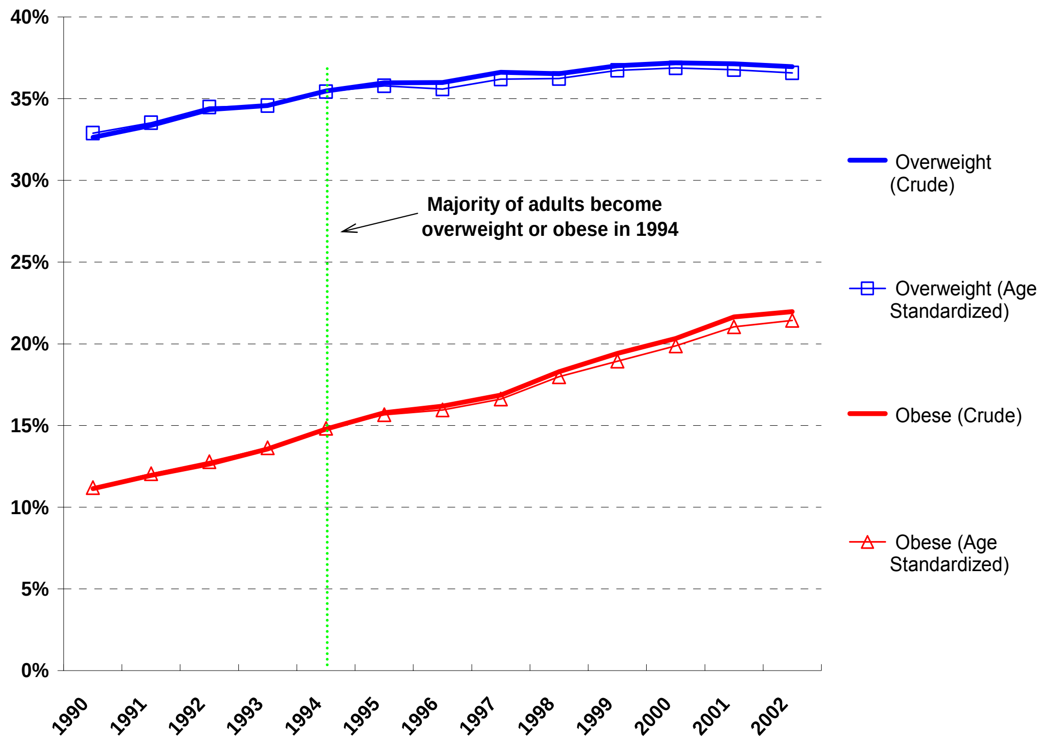

Figure 1: Crude and Age-Standardized Trends in the Percentage Overweight and Obese among Adults, Behavioral Risk Factor Surveillance System (BRFSS), 1990-2002

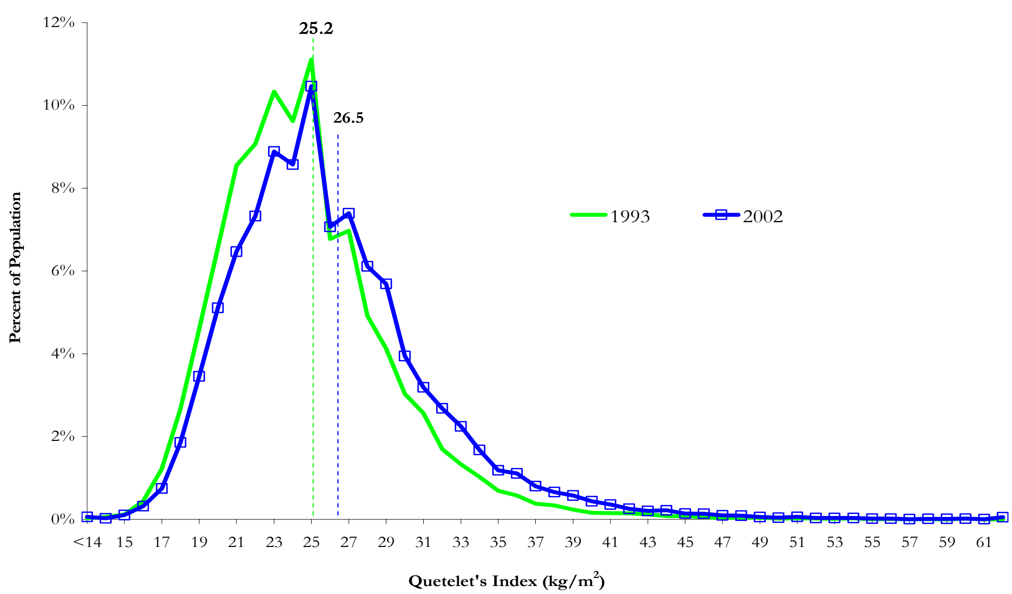

Figure 2: Rightward Shift of Body Mass Index (BMI) Frequency Distribution among Adults, Behavioral Risk Factor Surveillance System (BRFSS), 1993 and 2002

Table 1: Variable Definitions, Means, and Standard Deviations**

Variable	*Definition*	*Population* Mean	*Population* (SD)	*Obese* Mean	*Obese* (SD)	*Non-Obese* Mean	*Non-Obese* (SD)
Outcome Variables							
Body Mass Index (BMI)	Weight in kilograms divided by height in meters squared	25.953	(5.091)	34.347	(4.749)	24.243	(3.053)
Overweight	Dichotomous variable = 1 if BMI >= 25	0.525	(0.499)	1.000	(0.000)	0.429	0.495
Obese	Dichotomous variable = 1 if BMI >= 30	0.169	(0.375)	1.000	(0.000)	0.000	(0.000)
Individual Characteristics							
Age	Years since respondent's birth	44.463	(17.443)	46.476	(15.582)	44.052	(17.770)
Age Squared	Years since respondent's birth squared	2,281.161	(1725.315)	2,402.819	(1541.790)	2,256.376	(1759.332)
Female	Dichotomous variable = 1 if sex is female	0.494	(0.500)	0.487	(0.500)	0.496	(0.500)
Black	Dichotomous variable = 1 if respondent's ethno-racial group is non-Latino black	0.109	(0.312)	0.168	(0.374)	0.097	(0.296)
Latino	Dichotomous variable = 1 if respondent's ethno-racial group is Latino regardless of race	0.128	(0.335)	0.158	(0.365)	0.123	(0.328)
Other	Dichotomous variable = 1 if respondent's ethno-racial group is non-Latino Asian or other race	0.046	(0.209)	0.026	(0.160)	0.050	(0.217)
Individual Behavior							
High school graduate	Dichotomous variable = 1 if respondent completed 12-15 years of formal schooling	0.573	(0.494)	0.605	(0.489)	0.566	(0.496)
College graduate	Dichotomous variable = 1 if respondent graduated from college	0.307	(0.460)	0.230	(0.421)	0.323	(0.468)
Married	Dichotomous variable = 1 if respondent is married or cohabiting	0.594	(0.492)	0.607	(0.489)	0.591	(0.492)
Employed	Dichotomous variable = 1 if respondent is employed	0.647	(0.478)	0.637	(0.481)	0.649	(0.477)
Household income	Respondent's real annual household income in thousands of 1993 Dollars	38.061	(23.681)	35.118	(23.084)	38.661	(24.207)
Exercise	Dichotomous variable = 1 if participated in physical activity outside of work during past month	0.735	(0.428)	0.643	(0.479)	0.753	(0.431)
≥ 3 Servings of Fruits and Vegetables Daily	Dichotomous variable = 1 if respondent eats 3 or more servings of fruit and vegetables daily	0.244	(0.442)	0.215	(0.411)	0.250	(0.433)
Smoke	Dichotomous variable = 1 if respondent smoked cigarettes at time of interview	0.221	(0.416)	0.189	(0.392)	0.228	(0.419)
Metropolitan Context							
Income Inequality[a]	Metro-area Gini coefficient	0.403	(0.021)	0.403	(0.021)	0.403	(0.021)
Mean Household Income[a]	1990 median household income in thousands of dollars by metro area	31.760	(4.404)	31.465	(4.488)	31.821	(4.384)
Ethno-Racial Segregation[a]	Percent of non-whites in a metro area that would need to move across census tracts to achieve an even distribution	0.545	(0.097)	0.546	(0.096)	0.544	(0.097)
Black	Percent non-Latino African American by metro area	0.133	(0.084)	0.134	(0.086)	0.133	(0.084)
Rain[b]	Inches of rain in metro area's largest city during 2000	35.657	(14.248)	35.836	(14.023)	35.621	(14.293)
Temperature[b]	Number of heating degree days in metro area's largest city during 2000 (thousands)	4.056	(2.056)	4.054	(2.061)	4.056	(2.055)
Relative Fast-Food Price[c]	Ratio of a 1992 fast-food restaurant meal to a 1992 full-service restaurant meal by metro (1993 dollars)	0.499	(0.085)	0.502	(0.084)	0.499	(0.085)
Grocery ("Food at home") price[d]	Mean real price of 13 food items in 1992 in respondent's metro area (1993 dollars, see text for details)	5.005	(0.528)	4.977	(0.518)	5.010	(0.530)
N (Unweighted)		274,007		48,201		225,806	

**** Varaibles created from the 1993-2002 Behavioral Risk Factor Surveillence Survey (BRFSS) Data, except where superscripted under the "Metropolitan Context" cateogry. Metro-level income and residential segregation variables were created using the 1990 Sumary Tape File 3 (STF3) data (superscript "a"), weather variables were obtained from the National Climatic Data Center (NCDC) and superscripted with a "b", and food price data were generated from the Census of Retail Trade (CRT) and American Chamber of Commerce Researchers Association (ACCRA) data -- superscripted with a "c" and "d," respectively. 1993-2002 Year dummy variables not shown, but included in all regression models. All statistics were obtained using sample weights.**

Table 2: Determinants of Body Mass Index, Overweight, and Obesity among Adults in the United States by Metropolitan Area Estimated by Two-Stage Least Squares, 1993-2002

Explanatory Variable:	*BMI*		*OVERWEIGHT*		*OBESE*	
	(1a)	*(1b)*	*(2a)*	*(2b)*	*(3a)*	*(3b)*
Individual Characteristics						
Age	0.337 (0.006) [a]	0.337 (0.006) [a]	0.123 (0.002) [a]	0.123 (0.002) [a]	0.130 (0.003) [a]	0.130 (0.003) [a]
Age Squared	-0.003 (0.000) [a]	-0.003 (0.000) [a]	-0.001 (0.000) [a]	-0.001 (0.000) [a]	-0.001 (0.000) [a]	-0.001 (0.000) [a]
Female	-1.391 (0.029) [a]	-1.391 (0.029) [a]	-0.848 (0.014) [a]	-0.849 (0.014) [a]	-0.138 (0.019) [a]	-0.138 (0.020) [a]
Black	1.567 (0.064) [a]	1.572 (0.063) [a]	0.580 (0.022) [a]	0.581 (0.022) [a]	0.528 (0.026) [a]	0.531 (0.026) [a]
Latino	0.695 (0.098) [a]	0.689 (0.098) [a]	0.330 (0.038) [a]	0.326 (0.037) [a]	0.189 (0.049) [a]	0.189 (0.049) [a]
Asian and other	-1.116 (0.115) [a]	-1.125 (0.116) [a]	-0.447 (0.055) [a]	-0.449 (0.055) [a]	-0.493 (0.070) [a]	-0.497 (0.071) [a]
Individual Behavior						
High school graduate	-0.550 (0.071) [a]	-0.533 (0.070) [a]	-0.154 (0.022) [a]	-0.151 (0.020) [a]	-0.216 (0.037) [a]	-0.205 (0.037) [a]
College graduate	-1.398 (0.063) [a]	-1.385 (0.064) [a]	-0.477 (0.029) [a]	-0.473 (0.029) [a]	-0.583 (0.034) [a]	-0.577 (0.035) [a]
Married	0.014 (0.044)	0.012 (0.044)	0.108 (0.015) [a]	0.108 (0.015) [a]	-0.056 (0.021) [a]	-0.057 (0.021) [a]
Employed	-0.094 (0.043) [b]	-0.097 (0.043) [b]	0.062 (0.024) [a]	0.061 (0.023) [a]	-0.082 (0.020) [a]	-0.084 (0.020) [a]
Household income	-0.009 (0.001) [a]	-0.009 (0.001) [a]	-0.002 (0.000) [a]	-0.002 (0.000) [a]	-0.004 (0.000) [a]	-0.004 (0.000) [a]
Exercise	-0.716 (0.053) [a]	-0.713 (0.053) [a]	-0.191 (0.013) [a]	-0.191 (0.014) [a]	-0.400 (0.021) [a]	-0.398 (0.021) [a]
≥ 3 Servings of Fruits and Vegetables Daily	-0.243 (0.041) [a]	-0.243 (0.041) [a]	-0.144 (0.014) [a]	-0.143 (0.015) [a]	-0.129 (0.016) [a]	-0.129 (0.016) [a]
Smoke	-1.039 (0.077) [a]	-1.040 (0.077) [a]	-0.382 (0.027) [a]	-0.382 (0.027) [a]	-0.436 (0.041) [a]	-0.436 (0.041) [a]
Metropolitan Context						
Income Inequality[a]	-7.747 (1.784) [a]	-0.011 (3.757)	-1.944 (0.598) [a]	-0.322 (1.519)	-3.437 (1.085) [a]	1.361 (1.704)
Mean Household Income[a]	-0.040 (0.007) [a]	0.003 (0.029)	-0.012 (0.003) [a]	-0.006 (0.011)	-0.021 (0.004) [a]	0.009 (0.013)
Ethno-Racial Segregation[a]	1.906 (0.620) [a]	0.918 (0.587)	0.574 (0.263) [b]	0.257 (0.257)	0.823 (0.304) [a]	0.345 (0.287)
Black	0.068 (0.411)	-0.196 (0.363)	0.007 (0.158)	-0.093 (0.142)	-0.006 (0.214)	-0.105 (0.205)
Rain[b]	-0.007 (0.003) [b]	0.002 (0.007)	-0.001 (0.001)	0.000 (0.003)	-0.003 (0.001) [b]	0.003 (0.003)
Temperature[b]	0.004 (0.025)	0.013 (0.022)	0.003 (0.010)	0.008 (0.009)	-0.003 (0.012)	0.000 (0.010)
Relative Fast-Food Price[c]	-- --	-4.111 (1.439) [a]	-- --	-1.473 (0.586) [a]	-- --	-1.845 (0.746) [a]
Grocery ("Food at home") price[d]	-- --	-0.999 (0.284) [a]	-- --	-0.266 (0.109) [b]	-- --	-0.561 (0.137) [a]
Summary Statistics						
R^2 (or Psuedo-R^2 for Logistic Regressions)	0.1073	0.1076	0.0800	0.0801	0.0540	0.0544
F-statistic	1205.16	1309.29	NA	NA	NA	NA
Percent Concordant Pairs	NA	NA	0.6413	0.6414	0.8305	0.8306
Wald Chi-Squared	NA	NA	38,471.14	38,178.00	11,091.54	12,522.61
Sample Size (Unweighted)	274,007	274,007	274,007	274,007	274,007	274,007

*Estimated coefficients for intercepts and year dummies not shown. Robust (Huber 1967) standard errors are in parentheses and are generated by controlling for clustering at the 2003 OMB-defined metropolitan statistical area level. All results are produced employing BRFSS sample weights. Note: Statistically significant at the 99% (a), 95% (b), or 90% (c)

Table 3: Logit Analysis of Having Exercised during the Previous Month and Eaten at Least Three Servings of Fruits and Vegetables Daily among Adults in Metropolitan Areas of the United States, 1993-2002**

Explanatory Variable:	*Exercise*	*Diet*
	(1)	*(2)*
Individual Characteristics		
Age	-0.026 (0.002) [a]	-0.007 (0.002) [a]
Age Squared	0.000 (0.000) [a]	0.000 (0.000) [a]
Female	-0.148 (0.014) [a]	0.435 (0.011) [a]
Black	-0.268 (0.026) [a]	-0.063 (0.026) [b]
Latino	-0.454 (0.035) [a]	0.101 (0.055) [c]
Asian and other	-0.433 (0.057) [a]	0.190 (0.037) [a]
Individual Behavior		
High school graduate	0.534 (0.018) [a]	0.179 (0.027) [a]
College graduate	1.049 (0.024) [a]	0.465 (0.029) [a]
Married	-0.097 (0.012) [a]	0.066 (0.017) [a]
Employed	-0.051 (0.014) [a]	-0.155 (0.027) [a]
Household income	0.014 (0.000) [a]	0.002 (0.000) [a]
Smoke	-0.411 (0.013) [a]	-0.353 (0.023) [a]
Metropolitan Context		
Income Inequality	6.228 (1.606) [a]	7.355 (2.707) [a]
Mean Household Income	0.029 (0.008) [a]	0.062 (0.022) [a]
Ethno-Racial Segregation	-3.919 (0.741) [a]	-0.961 (0.346) [a]
Black	-0.544 (0.375)	-0.025 (0.250)
Rain	0.008 (0.004) [b]	0.014 (0.005) [a]
Temperature	0.077 (0.024) [a]	-0.007 (0.012)
Relative Fast-Food Price	-- --	1.812 (0.775) [b]
Grocery ("Food at home") price	-- --	-0.122 (0.222)
Summary Statistics		
Percent Concordant Pairs	0.7464	0.7556
Probability > Chi-Squared	0.0000	0.0000
Sample Size (Unweighted)	274,007	274,007

**Estimated coefficients for intercepts and year dummy variables not shown. Robust standard errors (Huber 1967) are in parentheses and are generated by controlling for clustering at the CBSA level. Results statistically significant at 99%(a), 95%(b), and 90%(c) level.