Published in final edited form as:

Res Aging. 2004 January 1; 26(1): 108–129. doi:10.1177/0164027503258738.

Aging, Obesity, and Mortality:

Misplaced Concern About Obese Older People?

Roland J. Thorpe Jr. and Kenneth F. Ferraro

Purdue University

Abstract

Although there is widespread agreement that obesity (body mass index [BMI] ≥ 30 kg/m²) raises health risks, debate has ensued on whether obese older adults are also at greater risk. This study examines the effect of obesity on mortality for younger and older adults to determine whether the risk of obesity is lessened in later life. Data from a 20-year follow-up of a national sample of adults were used to examine the risk of obesity on mortality ($N = 6,767$). Cox models reveal that obesity raises mortality risk for adults of all ages, but this relationship is nearly twice as strong for persons younger than 50 years of age. Being slightly overweight in later life is associated with lower mortality risk, but obesity raises mortality risk, especially for ischemic heart disease. Obesity in middle age is a grave public health concern, but obesity in later life also merits attention.

Keywords

aging; obesity; mortality; longitudinal study

Obesity (body mass index [BMI] ≥ 30 kg/m²) has been described as reaching epidemic proportions in the United States (Mokdad et al. 1999). Estimates vary across studies of the U.S. population, but between 18% to 25% of adults are now considered obese and another 30% are considered overweight (Flegal et al. 1998; Mokdad et al. 1999; Strauss and Pollack 2001). The social cost of obesity is also great, resulting in approximately 280,000 deaths per year (Allison et al. 1999; Must et al. 1999). Obesity has become a substantial public health problem in the United States, with no signs of even slowing its rising prevalence.

In an attempt to summarize the risk to society and prescribe appropriate clinical standards, the National Heart, Lung, and Blood Institute (NHLBI) published *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults* in 1998. The *Guidelines* specified normal weight for adults as a BMI ≤ 18.5 and < 25 . Underweight adults were defined as persons with a BMI < 18.5 ; overweight was defined as a BMI ≥ 25 and < 30 , and obesity was defined as a BMI ≥ 30 . The *Guidelines* was offered with some caveats, especially with regard to its application for older adults. This is because some studies of mortality have shown that obesity is significant in younger adults but not for older adults—suggesting that the risk of excess weight on health and mortality in the later years has been exaggerated (Andres, Muller, and Sorkin 1993; Linsted and Singh 1997). Andres (1995) concluded that “those who either maintain their weight or, better, gain small amounts of weight, show the lowest mortality” (p. 69). Understandably, this assertion has been the

source of much debate. Others have countered that obesity is a significant health risk throughout adulthood and that it may hasten disability and mortality in older adults, especially heart-disease-related deaths (Peeters et al. 2003; Willett, Dietz, and Colditz 1999).

The purpose of this article is to systematically reexamine the relationship between obesity and mortality for younger and older adults. We ask whether the risk of obesity on mortality is significant in later life. Although many studies show that obesity in young and middle-age adults heightens mortality risk, does it also raise mortality risk among obese people who survive into later life? The present research addresses this question by examining all-cause and heart-disease deaths in a national sample of adults.

AGE DIFFERENCES IN THE MORTALITY RISK OF OBESITY

Although there remains some debate on the precise shape of the relationship between BMI and mortality (U- or J-shape), most studies find that premature death due to obesity is more likely for both men and women (Durazo-Arvizu et al. 1998). When addressing why obesity may not be as consequential for older adults, most explanations draw on a life course perspective of BMI. As pertains to intra-individual variability in BMI, it is fairly well-known that BMI increases with age through the adult years except during later life when a leveling or decline occurs (Brown, Kaye, and Folsom 1992; Cornoni-Huntley et al. 1991; Grinker et al. 1995; Willett et al. 1995). In fact, age may be the most consistent and predominant factor related to weight variation over the life course. Willett et al. (1995) found that very few women between the ages of 30 and 55 who were followed for 14 years experienced weight loss; most gained weight.

Weight loss in adulthood is more likely in later life as energy intake is decreased due to loss of appetite, illness, sarcopenia, and perhaps depression or “failure to thrive” (Blazer 1993; Dutta and Hadley 1995; Evans 1995; Gurland, Dean, and Cross 1983; Meltzer and Everhart 1995; Sobal 1995; Williamson et al. 1995). In considering the link between BMI and mortality, Losonczy et al. (1995) found evidence among White persons 70 years or older that “low weight in old age is, therefore, more likely to be an indicator of poor health, and it is primarily the poor health, not the low weight per se, which causes the increased risk of mortality” (p. 312) (see also Harris et al. 1993; Pamuk et al. 1993; Williamson and Pamuk 1993; Williamson et al. 1995).

It has become increasingly clear that the curvilinear relationship between BMI and mortality risk is related to the life course. Older underweight persons are those most often close to death—the sequelae of chronic disease in modern societies. Obesity, on the other hand, accelerates the risk of hypertension, diabetes, and ischemic heart disease (IHD), thereby leading to premature mortality and a smaller proportion of obese older people. The question remains, however, whether people who are obese and make it into later life are still at greater risk of mortality. The answer to this question is important for health policy and medical practice: Should older people be encouraged or admonished to lose weight? If obesity is not as consequential to older people, then weight loss initiatives may be misdirected and, in some cases, may lead to adverse effects such as malnourishment or unnecessary surgery to facilitate weight loss. On the other hand, if obesity among older people is consequential to mortality risk, then failure to confront weight loss would decrease longevity.

There is a rich body of research on obesity and mortality to inform this research question. Nevertheless, there are four concerns apparent in much of the previous research that we seek to address in this research. First, many of the previous studies of obesity and mortality are based on samples that are limited by sex (e.g., Hoffmans, Kromhout, and Coulander 1989), race (Williamson et al. 1999), occupation (Manson et al. 1995), or other characteristics.

Thus, part of the debate may actually be due to external validity. The analyses undertaken here are based on a national sample of adults from ages 25 to 74 at the beginning of the study who were followed 20 years.

Second, there is debate as to how investigators handle morbidity at entry to a study (Diehr et al. 1998). Some argue that because hypertension and diabetes, for example, “are intermediate steps in the causal pathway linking obesity to increased mortality” that these forms of morbidity should not be controlled (Manson et al. 1995:682). Others control for such health conditions in the interest of identifying the net effects of obesity on mortality (e.g., Cornoni-Huntley et al. 1991; Losonczy et al. 1995). Of course, if obesity is related to disease at entry into a study, controlling for it would likely reduce the direct effect on mortality. For selected analyses presented below, models with and without controls for morbidity will be compared.

Third, it is possible that many studies have failed to report an effect for obesity on mortality among older people because of statistical power (Cohen 1988). The effect of obesity on mortality earlier in the life course likely reduces the number of obese people in the population of older adults. Moreover, as noted earlier, weight loss in advanced old age is very common. Together, these factors result in a relatively small proportion of obese older people. Thus, it is possible that the absence of a significant effect of obesity on mortality for older people could be due to the sheer fact that there are insufficient cases in a probability sample to even detect a relationship. The present analysis includes tests for statistical power to assure that the absence of a significant effect is not due to statistical power.

Finally, related to statistical power and effect size, the measurement of BMI itself may obscure relationships between it and mortality. Many studies rely on self-reported weight and height. This is typically not considered a major problem because previous research has shown that measured and self-reported weights are strongly correlated (Bowman and DeLucia 1992). This is not likely a major problem when categorical forms of weight categories are used—such as the NHLBI categories—but coupled with the prospect of insufficient statistical power, self-reports may make it more difficult to find a relationship between obesity and mortality among older people. The analyses presented below are based on measured weight and height.

The present research is designed to provide a life-course view of the consequences that obesity has on mortality. Two basic research questions guide the analysis:

- Does obesity increase the likelihood of mortality for older people?
- If yes, is the risk of obesity on mortality greater in middle or older ages?

Although IHD is a major pathway for the effect of obesity on mortality, the previous two questions are also addressed with this specific cause of death. For both the all-cause and cause-specific analyses, statistical power is systematically considered to avoid concluding that obesity is not related to mortality because of insufficient statistical power.

Method

SAMPLE

Data from the National Health and Nutrition Examination Survey I (NHANES I) and its Epidemiologic Follow-Up Study (NHEFS) are used in this research (Cox et al. 1997). The baseline NHANES I was conducted from 1971 to 1975. The sampling design was a multistage, stratified, probability sample of noninstitutionalized persons aged 25 to 74 years of age. This study makes use of data from the baseline survey and the mortality follow-up through 1992 (about 20 years).

The analyses were completed on the NHEFS subsample that was administered the “detailed component” including the Health Care Needs Questionnaire at baseline ($N = 6,913$). The sample used in this study is composed of 5,955 White and 878 Black respondents at baseline. Women who gave birth one year before or after the survey were omitted (resulting in a sample of 6,767). All analyses presented below are based on the weighted sample and have been adjusted by Taylor-linearization procedures in Stata 7.0 to account for the multistage sampling design.

MORTALITY

Vital status was determined at the follow-up surveys for all traced respondents, and death certificates confirmed death for 98.7% of the deceased. Cause of death was coded using the *International Classification of Disease* (9th revision) (World Health Organization 1978). Brief interviews were conducted with proxies of deceased respondents. In addition, matches were made for all participants in the baseline survey to the National Death Index, the Social Security Administration Mortality File, and the enrollment file of the Health Care Financing Administration (Cox et al. 1997). Date of death was obtained for 1,936 decedents, so continuous-time event history models were applied.

In addition to all-cause mortality, IHD deaths were also studied. Deaths due to IHD included angina pectoris, coronary artery disease, and myocardial infarction, which are identified by the ICD-9 codes of 410–414.9.

MEASUREMENT OF BODY WEIGHT

BMI was defined as kilograms/meters². BMI was measured continuously for each respondent and analyzed categorically according to the NHLBI guidelines. Research staff measured weight and height. Weight was measured by a Toledo self-balancing scale to one quarter pound, with participants wearing examination slippers and gown (Cornoni-Huntley et al. 1991). Height was measured with a level platform and attached measuring rod.

MEASUREMENT OF COVARIATES

The remaining independent variables span a broad range of risk factors for obesity, either directly or indirectly. Demographic variables include age, female, Black, lives alone, and widowed. Age at baseline was calculated as the difference between the year in which the respondent was interviewed and their birth year. A binary variable was created to identify subjects 50 years or older (scored 0 = less than 50, 1 = 50 or more). Additional age cutoff points were examined, but, as mentioned earlier, statistical power became a problem with higher cutoff points for age. This illustrated the importance of statistical power for these types of analyses; the analyses presented below have sufficient statistical power. In addition, the results should be considered in light of the age of subjects when the study began and the length of the study. The older subjects were between 50 and 74 years of age at baseline and between 70 and 94 years of age by the final follow-up.

All other binary variables were also coded 0 and 1, with 1 equal to the name of the variable. Variables related to socioeconomic resources included education (8 categories) and household income (12 categories) and three binary variables related to medical care access: availability of private health insurance, Medicaid status, and regular physician. Education was measured in the highest grade or year of regular school attended and categorized according to standard education classifications. The categories included: no years of education, elementary, middle school, first three years of high school, fourth year of high school (high school graduate), some college, four years of college (college graduate), and graduate school. This type of classification reflects the achievement patterns that are embedded in the educational system in the United States. It places emphasis on each level of

educational achievement—for example, high school dropouts versus high school graduates—instead of giving all years of education the same weight. Household income was measured at baseline by asking respondents to pick the income range that represented their total family income for the past 12 months (in the early 1970s). The income categories included: < \$1,000, \$1,000 to 1,999, \$2,000 to 2,999, \$3,000 to \$3,999, \$4,000 to \$4,999, \$5,000 to \$5,999, \$6,000 to \$6,999, \$7,000 to \$9,999, \$10,000 to \$14,999, \$15,000 to \$19,999, \$21,000 to \$24,999, and > \$25,000. Supplementary analyses treating each category of education (and income) as a separate binary variable, with alternative reference groups, were performed but did not alter the conclusions presented below.

Current and past smokers were identified by self-report of consumption of cigarettes, cigars, and pipe tobacco at the time of the interview and during one's lifetime. Respondents were also asked to rate how much exercise they get "in your usual day" from both recreational and nonrecreational activities. A binary variable for regular exercise was created to identify respondents who were quite active in both questions (1 = regular exercise, 0 = otherwise). Some indicator of physical activity is important for the study of obesity and mortality, but it should be noted that this measure is a crude index of activity that could be due to limited function or lifestyle.

For selected analyses, morbidity was also included as a risk factor. Morbidity measures were derived from a checklist based on the following question: "Has a doctor ever told you that you have ... hypertension or high blood pressure, heart failure, or a heart attack?" (36 conditions presented). Self-reported measures have been shown to have considerable predictive validity, especially when referencing a physician's evaluation of disease (Ferraro and Farmer 1999). Each condition was coded as a binary variable (1 = present, 0 = otherwise) and then classified into those that were life-threatening or serious and all remaining conditions. Serious conditions included cancer, diabetes, heart trouble (attack or failure), hypertension, and stroke. Heart trouble was derived from those individuals who responded yes to either being told they had a heart attack or heart failure. Examples of chronic nonserious conditions included arthritis, asthma, cataracts, gout, psoriasis, and ulcer. The chronic nonserious conditions were then summed separately. Stroke was not included in our models because there were no cases reported at baseline. Each of the remaining serious conditions was entered into the models separately.

Means and standard deviations of all variables for the total sample, and by age categories at the baseline, are presented in Table 1. Several additional variables, such as rural residence and women's menopause status, were considered in preliminary analyses but deleted from the final analysis because they were nonsignificant in multivariate models.

ANALYTIC PLAN

The present analysis was designed to provide a life-course examination of the consequences that obesity has on all-cause and IHD mortality. First, we examined the net effects of obesity at baseline on the risk of all-cause mortality for the total sample and by age categories. These analyses were structured hierarchically to examine the role of control variables, such as morbidity, in mediating the relationship between obesity and mortality.

Second, given the mediating role that disease plays in the relationship between obesity and mortality, we examined the net effects of obesity on deaths due to IHD. Two models were estimated for the total sample and each age category. The first model excluded the heart trouble variable (at baseline), whereas the second model included it. The logic of these analyses are twofold: (a) to determine whether obesity raises the risk of IHD mortality when considering only individuals who died from some form of IHD and (b) to determine the effect, if any, that heart trouble at study entry had on obesity as it relates to IHD mortality.

Finally, we assessed whether obesity at baseline raised the risk of IHD mortality among the individuals who were free of heart trouble at baseline (asymptomatic) for the total sample and by age categories. Cox models were used to obtain risk ratios and confidence intervals for all-cause and IHD deaths during this 20-year study.

Results

As shown in Table 1, there were 6,767 participants, 46% of whom were normal weight, 34% who were overweight, 15% who were obese, and less than 3% who were underweight at baseline. Table 2 presents the findings for all-cause mortality for the total sample and by age categories. Reduced and full models are presented to inform the analysis and discussion. Results for the total sample (three models) are presented first, followed by estimates for younger (age < 50) and older (age ≥ 50) people. Model 1 for the total sample includes age and the NHLBI categories, Model 2 includes the variables in Model 1 plus the demographic and health behavior variables, and Model 3 includes the variables in Model 2 plus the prevalent disease variables at baseline.

For the total sample, older people (relative risk [RR] = 7.17, 95% confidence interval [CI] = 6.51–7.91), underweight people (RR = 1.93, 95% CI = 1.29–2.90), and obese people (RR = 1.41, 95% CI = 1.25–1.60) were at an increase risk of all-cause mortality (Model 1). When adjustment was made for the demographic and health behavior variables, the results were very similar to results in Model 1 and substantiates that obese people (RR = 1.34, 95% CI = 1.21–1.48) were at an increased risk of all-cause mortality (Model 2). The results from the model that includes the prevalent disease variables yielded similar results as Model 2; however, note that overweight people (RR = 0.88, 95% CI = 0.80–0.97) had a decreased risk of all-cause mortality (Model 3).

Among the younger people, being overweight (RR = 1.43, 95% CI = 1.02–2.01) or being obese (RR = 2.50, 95% CI = 1.94–3.24), compared to being normal weight, raised the risk of all-cause mortality (Model 1). Being obese (RR = 1.92, 95% CI = 1.55–2.39) compared to being normal weight remained as an increased risk for all-cause mortality even after controlling for demographic and health behavior variables, but the effect for overweight was no longer significant (Model 2). Even after controlling for prevalent diseases, obese people (RR = 1.66, 95% CI = 1.33–2.08) had higher all-cause mortality risk (Model 3) than normal-weight people.

Among the older people, underweight (RR = 2.02, 95% CI = 1.24–3.29) and obese (RR = 1.25, 95% CI = 1.07–1.45) people were more likely than normal-weight people to have higher risk of all-cause mortality (Model 1). Underweight (RR = 1.58, 95% CI = 1.04–2.40) and obese (RR = 1.22, 95% CI = 1.09–1.35) people had a higher risk of all-cause mortality than normal-weight people. Note, however, that overweight (RR = 0.87, 95% CI = 0.77–0.89) people manifest a lower risk of all-cause mortality (Model 2). The full model, which adds the prevalent disease variables, reveals that, in comparison to normal-weight people, underweight persons manifested higher mortality risk (RR = 1.60, 95% CI = 1.05–2.43), but overweight persons manifested lower mortality risk (RR = 0.82, 95% CI = 0.72–0.94). In addition, obesity was no longer significant (Model 3). This shows the indirect effect of obesity on mortality through disease—obese older people are more likely to develop the serious illnesses, and these illnesses accelerate mortality risk.

Given that disease plays a mediating role in the relationship between obesity and mortality for older people, the second stage of the analysis was to examine the effects of obesity on cause-specific mortality. (Three causes were considered in preliminary analyses—IHD, cancer, and cerebrovascular disease—but there was insufficient statistical power for cancer

and cerebrovascular disease.) Table 3 presents the analysis for the underlying cause of death coded as IHD for the total sample and by age categories. We wanted to distinguish whether heart trouble at entry of the study altered the relationship between obesity and IHD mortality. Two models for estimating IHD mortality are presented for total sample and by age categories. The first excludes heart failure at baseline as a predictor; the second includes it.

Our findings were not markedly different for IHD mortality. For the total sample, older and obese people were at an increased risk of IHD mortality in both models; however, one notable difference is that the effect of hypertension and diabetes is reduced in the model that controls for heart failure (Model 2).

Among the younger people, obesity, past smokers, hypertension, and diabetes raised the risk of IHD mortality in both models. Notably, Black persons, people with heart failure, and people who exercise regularly are not significantly different in terms of IHD mortality risk.

Among the older people, underweight, obesity, current smoking, hypertension, and diabetes are associated with an increased risk of IHD mortality. It is apparent that obesity is significantly related to higher IHD mortality in all models and for both age groups.

In the final stage of the analyses, we examined whether obesity at baseline raises the risk of IHD mortality among the individuals who were free of heart failure at baseline (asymptomatic). This analysis is distinct from the above analysis because of our interest to determine whether patterns of association between obesity and IHD mortality were influenced by heart failure. Therefore, we eliminated those individuals who reported heart trouble at baseline. Again, these models are estimated for the total sample and by age categories in Table 4. For the total sample, asymptomatic older people were nearly six times more likely than younger people to die of heart disease. Obesity and past smoking are associated with increased risk of IHD mortality for the total sample and among the younger people. Among the older group of people, none of the NHLBI categories are associated with a risk of IHD mortality. In other words, if people can reach 50 years of age without heart trouble, being obese does not further escalate mortality risk due to IHD. Also noteworthy is the salubrious effect of regular exercise, especially for older people.

Discussion

Are older obese people at heightened risk of mortality? This question has prompted a number of studies examining the relationship between age, obesity, and mortality. The absence of an effect of obesity on mortality in later life was reported in several studies, suggesting that there may be misplaced concern about older people who are obese (Andres 1995); Andres et al. 1993; Linsted and Singh 1997). Even the NHLBI offered caveats with the 1998 *Guidelines*, indicating that the BMI categories may work less well for older people.

Using data from the NHEFS, the present investigation found that obesity raises mortality risk for adults of all ages. To be clear, the effect of obesity on mortality is about twice as strong for persons younger than 50 years of age, compared to those 50 years of age or older (Fontaine et al. 2003). Obesity in middle age is a grave health risk. At the same time, obesity in later life predicted premature mortality, especially for IHD. The results from the NHEFS suggest that the concern about obesity and mortality in later life is not misplaced. Obesity raises the risk of death for older men and women, and these results are consistent with recent findings from the Framingham Study (Peeters et al. 2003).

One of the conclusions from the analyses performed was the importance of statistical power when studying the relationship between obesity (or underweight) and mortality in later life

(Cohen 1988; Ferraro and Wilmoth 2000). As noted above, obesity in middle age raises the risk of premature death, thereby leading to nonrandom selection in later life. The cohort is changed and the proportion of obese elders is relatively small. It is possible that the failure of some previous studies to uncover a relationship between obesity and mortality in later life is simply due to insufficient statistical power. Indeed, in supplementary analyses, we selected alternative cutoff points for age to examine this possibility. Those analyses revealed that there was sufficient statistical power to detect an effect of obesity on mortality for older people when the threshold was defined up through 53 years of age ($p < .05$). When dividing the sample into groups of younger than 54 and 54 and older, power dropped below .8. In other words, had we selected a cut-point of 60 or 65 years of age, the conclusion would have been that obesity does not influence mortality—and that “result” would have been due to insufficient statistical power. Investigators may not feel it necessary to estimate statistical power when using “large” samples, but the analyses presented herein show the importance of statistical power in studying the relationship between obesity and mortality among older people. We urge investigators to consider statistical power as one possible reason for the situation in which an effect is observed among younger people but not among older people.

Why else might previous studies not have observed a significant relationship between obesity and mortality in later life? Some investigators have argued that “overadjustment” may be a problem. As Diehr et al. (1998:624) described it, the problem arises in mortality studies by “controlling inappropriately for factors that may have been affected by the person’s weight.” For selected analyses, results including and excluding morbidity variables were compared, and it was discovered that, indeed, adjusting for the disease variables eliminated the effect of obesity on all-cause mortality among older people. Reduced models revealed that obesity was related to mortality, thus showing the mediating role of disease. Obesity raises the risk of several diseases, and these diseases lead to premature mortality.

Furthermore, in analyses regarding IHD, the results were very robust: Obesity raises the risk of heart disease death for both younger and older adults. Regardless of controls for morbidity, obesity was consistently related to IHD deaths. As such, the public health mandate is clear: Older people are not immune to the lethal effects of obesity.

Although these data are clear that obese older people are at greater risk of premature death, there is no evidence that the effect is parallel for overweight older people. Being slightly overweight in later life was associated with lower mortality risk, and it is this set of older adults for whom Andres’ (1995:69) recommendation may be appropriate: “those who either maintain their weight or, better, gain small amounts of weight, show the lowest mortality.” Modest weight gain may be fine for overweight persons but not for obese persons (Ferraro et al. 2002). The results from this study are consistent with others showing that there is no justification for identifying overweight older persons as at high risk of mortality (Strawbridge, Wallhagen, and Shema 2000).

The present analysis is not without its limitations. First, the upper age of NHEFS was 74 years at baseline. With a 20-year follow-up, the older subjects could attain an age of 70 to 94. This is a long observation period and sufficient to address the research questions articulated. At the same time, the ceiling on age at baseline precluded using higher cutoff points for age group comparisons. It also may influence effect size for underweight persons. Second, cause-specific analyses for cancer and cerebrovascular disease were also planned. Preliminary analysis, including tests of statistical power, revealed that the proposed analyses were not sufficiently powered. It is important for research on obesity and mortality in later life to consider other diseases as mediators. Cancer, in particular, is intriguing because chemotherapy often results in weight loss. Indeed, this may be one instance in which

overweight persons are advantaged somewhat. It remains to be seen whether such an effect extends to obese persons.

The results of this research show that obesity in middle age is a grave public health concern. Obese middle-aged persons are more than twice as likely as normal-weight persons to die prematurely. At the same time, obesity in later life also raises mortality risk. Underweight older persons have the highest risk of mortality, but obese older persons also are at risk. The concern about obese older persons has not been misplaced because the relationship between BMI and mortality is U-shaped.

Acknowledgments

Support for this research was provided by grants from the National Institute on Aging to the second author (R01 AG 13739, K07 AG01055). The authors appreciate the assistance of Jessica Kelley-Moore and Ya-ping Su with the construction of selected variables. The data used in this article were made available by the Inter-University Consortium for Political and Social Research. Neither the collector of the original data nor the Consortium bears any responsibility for the analyses or interpretations presented herein.

REFERENCES

- Allison, David B.; Fontaine, Kevin R.; Manson, JoAnn E.; Stevens, June; VanItallie, Theodore B. Annual Deaths Attributable to Obesity in the United States. *Journal of the American Medical Association*. 1999; 282:1530–1538. [PubMed: 10546692]
- Andres, Reubin. Body Weight and Age. In: Brownell, Kelly D.; Fairburn, Christopher G., editors. *Eating Disorders and Obesity*. New York: Guilford; 1995. p. 65-70.
- Andres, Reubin; Muller, Dennis C.; Sorkin, John D. Long-Term Effects of Change in Body Weight on All-Cause Mortality A Review. *Annals Internal Medicine*. 1993; 119:737–743.
- Blazer, Dan. *Depression in Late Life*. St. Louis, MO: Mosby; 1993.
- Bowman, Robert L.; DeLucia, Janice L. Accuracy of Self-Reported Weight: A Meta-Analysis. *Behavior Therapy*. 1992; 23:637–655.
- Brown JE, Kaye SA, Folsom AR. Parity-Related Weight Change in Women. *International Journal of Obesity and Related Metabolic Disorders*. 1992; 16:627–631. [PubMed: 1328085]
- Cohen, Jacob. *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NJ: Lawrence Erlbaum; 1988.
- Cornoni-Huntley, Joan C.; Harris, Tamara B.; Everett, Donald F.; Albanes, Demetrius; Micozzi, Marc S.; Miles, Toni P.; Feldman, Jacob J. An Overview of Body Weight of Older Persons, Including the Impact on Mortality. The National Health and Nutrition Examination Survey I—Epidemiologic Follow-Up Study. *Journal of Clinical Epidemiology*. 1991; 44:743–753. [PubMed: 1941025]
- Cox, CS.; Mussolino, ME.; Rothwell, ST.; Lane, MA.; Golden, CD.; Madans, J.; Feldman, JJ. *Vital and health statistics*. Vol. Vol. 1. Hyattsville, MD: National Center for Health Statistics; 1997. Plan and Operation of the NHANES I Epidemiologic Follow-Up Study, 1992.
- Diehr, Paula; Bild, Diane E.; Harris, Tamara B.; Duxbury, Andrew; Siscovick, David; Rossi, Michelle. Body Mass Index and Mortality in Nonsmoking Older Adults: The Cardiovascular Health Study. *American Journal of Public Health*. 1998; 88:623–629. [PubMed: 9551005]
- Durazo-Arvizu, Ramon A.; McGee, Daniel L.; Cooper, Richard S.; Liao, Youlian; Luke, Amy. Mortality and Optimal Body Mass Index in a Sample of the U.S. Population. *American Journal of Epidemiology*. 1998; 147:739–749. [PubMed: 9554415]
- Dutta, Chhanda; Hadley, Evan C. The Significance of Sarcopenia in Old Age (Special issue). *Journals of Gerontology Series A—Biological Sciences & Medical Sciences*. 1995; 50A:1–4.
- Evans, Williams J. What Is Sarcopenia? *Journals of Gerontology Series A—Biological Sciences & Medical Sciences*. 1995; 50A:5–8.
- Ferraro, Kenneth F.; Farmer, Melissa M. Utility of Health Data from Social Surveys: Is There a Gold Standard for Measuring Morbidity? *American Sociological Review*. 1999; 64:303–315.

- Ferraro, Kenneth F.; Su, Ya-Ping; Gretebeck, Randall J.; Black, David R.; Badylak, Stephen F. Body Mass Index and Disability in Adulthood: A 20-Year Panel Study. *American Journal of Public Health*. 2002; 92:834–840. [PubMed: 11988456]
- Ferraro, Kenneth F.; Wilmoth, Janet. Measuring Morbidity: Disease Counts, Binary Variables, and Statistical Power. *Journal of Gerontology: Social Sciences*. 2000; 55B:S173–S189.
- Flegal KM, Carroll MD, Kuczmarski RJ, Johnson CL. Overweight and Obesity in the United States: Prevalence and Trends, 1960–1994. *International Journal of Obesity and Related Metabolic Disorders*. 1998; 22:39–47. [PubMed: 9481598]
- Fontaine, Kevin R.; Redden, David T.; Wang, Chenxi; Westfall, Andrew; Allison, David B. Years of Life Lost Due to Obesity. *Journal of the American Medical Association*. 2003; 289:187–193. [PubMed: 12517229]
- Grinker, Joel A.; Tucker, Katherine; Vokonas, Pantel S.; Rush, David. Body Habitus Changes Among Adult Males from the Normative Aging Study: Relations to Aging, Smoking History and Alcohol Intake. *Obesity Research*. 1995; 3:435–446. [PubMed: 8521163]
- Gurland, Barry J.; Dean, Laura L.; Cross, Peter S. The Effects of Depression on Individual Social Functions in the Elderly. In: Breslau, Lawrence D.; Haug, Marie R., editors. *Depression and Aging*. New York: Springer; 1983.
- Harris, Tamara B.; Ballard-Barbasch, Rachel; Madans, Jennifer; Makuc, Diane M.; Feldman, Jacob J. Overweight, Weight Loss, and Risk of Coronary Heart Disease in Older Women The NHANESI Epidemiologic Follow-Up Study. *American Journal of Epidemiology*. 1993; 137:1318–1327. [PubMed: 8333413]
- Hoffmans M, Kromhout D, Coulander C. Body Mass Index at the Age of 18 and Its Effects on 32-Year Mortality From Coronary Heart Disease and Cancer: A Nested Case Control Study Among the Entire 1932 Dutch Male Birth Cohort. *Journal of Clinical Epidemiology*. 1989; 42:513–520. [PubMed: 2738614]
- Linsted, Kristian; Singh, Pramit N. Body Mass and 26-Year Risk of Mortality Among Women Who Never Smoked: Findings from the Adventist Mortality Study. *American Journal of Epidemiology*. 1997; 146:1–11. [PubMed: 9215218]
- Losonczy, Katalin G.; Harris, Tamara B.; Cornoni-Huntley, Joan C.; Simonsick, Eleanor M.; Wallace, Robert B.; Cook, Nancy R.; Ostfeld, Adrian M.; Blazer, Dan G. Does Weight Loss from Middle Age to Old Age Explain the Inverse Weight Mortality Relation in Old Age? *American Journal of Epidemiology*. 1995; 141:312–321. [PubMed: 7840109]
- Manson, JoAnn E.; Willett, Walter C.; Stampfer, Meir J.; Colditz, Graham A.; Hunter, David J.; Hankinson, Susan E.; Hennekens, Charles H.; Speizer, Frank E. Body Weight and Mortality Among Women. *New England Journal of Medicine*. 1995; 333:677–685. [PubMed: 7637744]
- Meltzer, Arthur A.; Everhart, James E. Unintentional Weight Loss in the United States. *American Journal of Epidemiology*. 1995; 142:1039–1046. [PubMed: 7485049]
- Mokdad, Ali H.; Serdula, Mary K.; Dietz, William H.; Bowman, Barbara A.; Marks, James S.; Koplan, Jeffrey P. The Spread of the Obesity Epidemic in the United States, 1991–1998. *Journal of the American Medical Association*. 1999; 282:1519–1522. [PubMed: 10546690]
- Must, Aviva; Spadano, Jennifer; Coakley, Eugenie H.; Field, Alison E.; Colditz, Graham; Dietz, William H. The Disease Burden Associated with Overweight And Obesity. *Journal of the American Medical Association*. 1999; 282:1523–1529. [PubMed: 10546691]
- National Heart, Lung, and Blood Institute. *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults* (NIH Publication No. 98-4083). Bethesda, MD: National Institutes of Health; 1998.
- Pamuk, Elsie R.; Williamson, David F.; Serdula, Mary K.; Madans, Jennifer; Byers, Tim E. Weight Loss and Subsequent Death in a Cohort of U.S. Adults. *Annals of Internal Medicine*. 1993; 119:744–748. [PubMed: 8363209]
- Peeters, Anna; Barendregt, Jan J.; Willekens, Frans; Mackenbach, Johan P.; Al Mamun, Abdullah; Bonneux, Luc. Obesity in Adulthood and Its Consequences for Life Expectancy: A Life-Table Analysis. *Annals of Internal Medicine*. 2003; 138:24–32. [PubMed: 12513041]
- Sobal, Jeffrey. Social Influences on Body Weight. In: Brownell, Kelly D.; Fairburn, Christopher G., editors. *Eating Disorders and Obesity*. New York: Guilford; 1995. p. 73-77.

- Strauss, Richard S.; Pollack, Harold A. Epidemic Increase in Childhood Overweight, 1986–1998. *Journal of the American Medical Association*. 2001; 286:2845–2848. [PubMed: 11735760]
- Strawbridge, William J.; Wallhagen, Margaret I.; Shema, Sarah J. New NHLBI Clinical Guidelines for Obesity and Overweight: Will They Promote Health? *American Journal of Public Health*. 2000; 90:340–343. [PubMed: 10705849]
- Willett, Walter C.; Dietz, William H.; Colditz, Graham A. Guidelines for Healthy Weight. *New England Journal of Medicine*. 1999; 341:427–434. [PubMed: 10432328]
- Willett, Walter C.; Manson, JoAnn E.; Stampfer, Meir J.; Colditz, Graham A.; Rosner, Bernard; Speizer, Frank E.; Hennekens, Charles H. Weight, Weight Change, and Coronary Heart Disease in Women Risk Within the “Normal” Weight Range. *Journal of the American Medical Association*. 1995; 273:461–465. [PubMed: 7654270]
- Williamson, David F.; Pamuk, Elsie R. The Association between Weight Loss and Increased Longevity. A Review of the Evidence. *Annals of Internal Medicine*. 1993; 119:731–736. [PubMed: 8363207]
- Williamson, David F.; Pamuk, Elsie; Thun, Michael; Flanders, Dana; Byers, Tim; Heath, Clark. Prospective Study of Intentional Weight Loss and Mortality in Never-Smoking Overweight U.S. White Women Aged 40–64 Years. *American Journal of Epidemiology*. 1995; 141:1128–1141. [PubMed: 7771451]
- Williamson, David F.; Pamuk, Elsie; Thun, Michael; Flanders, Dana; Byers, Tim; Heath, Clark. Prospective Study of Intentional Weight Loss and Mortality in Overweight White Men Aged 40–64 Years. *American Journal of Epidemiology*. 1999; 149:491–503. [PubMed: 10084238]
- World Health Organization. *International Classification of Diseases, 9th Revision*. Geneva, Switzerland: Author; 1978.

Biographies

Roland J. Thorpe, Jr. is a doctoral candidate in epidemiology at Purdue University. He also holds a graduate minor in gerontology. His research focuses on epidemiology of obesity among older adults using a life-course perspective. Recent work appears in Journal of Gerontology: Social Sciences.

Kenneth F. Ferraro is professor of sociology and director of the Center on Aging and the Life Course at Purdue University. His research interests include racial health inequality and the effects of obesity on health. Recent works appear in the American Sociological Review and Journal of Gerontology: Social Sciences.

TABLE 1

Means and Standard Deviations of Variables in the National Health and Nutrition Examination Survey I (1971–1975): Total Sample and by Age Categories

Variable	Total (N = 6,767)	Age < 50 (N = 3,451)	Age ≥ 50 (N = 3,316)
Age (50 years and older)	.423		
Underweight (BMI < 18.5)	.029	.030	.029
Normal Weight (18.5 ≤ BMI < 25)	.469	.517	.403***
Overweight (25 ≤ BMI < 30)	.346	.327	.372**
Obesity (BMI ≥ 30)	.156	.127	.196***
Female	.522	.511	.535
Black	.102	.111	.090*
Lives alone	.110	.075	.157***
Widowed	.072	.015	.150***
Education (7 = graduate school)	3.85 (.034)	4.21 (.037)	3.36 (.045)***
Income (12 = \$25,000+)	7.90 (.062)	8.39 (.067)	7.24 (.073)***
Private medical insurance	.845	.835	.859*
Medicaid	.030	.025	.038*
Regular physician	.849	.829	.876***
Smoker	.448	.501	.375***
Past smoker	.256	.228	.295***
Regular exercise	.921	.931	.908**
Heart trouble	.063	.024	.117***
Hypertension	.211	.138	.310***
Diabetes	.044	.021	.074***
Cancer	.022	.010	.039***
Non-serious illness (0–4)	.266 (.006)	.129 (.007)	.453 (.013)***
Deceased by wave 4	.239	.078	.460***

NOTE: BMI = body mass index. The number of cases varies because of missing data. Age and all other binary variables are coded 0 and 1 (standard deviations of binary variables are omitted). The mean of a binary variable scored 0 and 1 reflects the percentage of cases with that attribute. Tests of significance are for differences by age categories, *t* test, or chi-square.

*
 $p < .05$

**
 $p < .01$

 $p < .001$.

TABLE 2

All-Cause Mortality Risk Ratios and Confidence Intervals for Total Sample and by Age Categories: National Health and Nutrition Examination Survey: Epidemiologic Follow-Up Study, 1971–1992

Independent Variable	Total Sample			Age < 50			Age 50		
	Model 1 (N = 6,529)	Model 2 (N = 6,497)	Model 3 (N = 6,497)	Model 1 (N = 3,258)	Model 2 (N = 3,243)	Model 3 (N = 3,243)	Model 1 (N = 3,271)	Model 2 (N = 3,254)	Model 3 (N = 3,254)
Age (50 years and older)	7.17*** ^a	6.21***	5.61***						
	6.51–7.91 ^b	5.48–7.04	4.91–6.42						
Underweight (BMI < 18.5) ^c	1.93**	1.54*	1.55*	1.60	1.39	1.44	2.02**	1.58*	1.60*
	1.29–2.90	1.05–2.24	1.07–2.27	1.00–2.54	0.85–2.29	0.87–2.36	1.24–3.29	1.04–2.40	1.05–2.43
Overweight (BMI 25 & < 30)	1.01	0.93	0.88**	1.43*	1.16	1.11	0.92	0.87*	0.82**
	0.92–1.10	0.85–1.02	0.80–0.97	1.02–2.01	0.84–1.60	0.82–1.51	0.79–1.07	0.77–0.98	0.72–0.94
Obese (BMI ≥ 30)	1.41***	1.34***	1.18**	2.50***	1.92***	1.66***	1.25**	1.22***	1.07
	1.25–1.60	1.21–1.48	1.04–1.33	1.94–3.24	1.55–2.39	1.33–2.08	1.07–1.45	1.09–1.35	0.93–1.23
Female		0.56***	0.54***		0.50***	0.49***		0.58***	0.55***
		0.51–0.62	0.50–0.58		0.41–0.60	0.40–0.59		0.51–0.66	0.49–0.61
Black		1.07	1.01		1.53	1.48		0.94	0.88
		0.85–1.34	0.81–1.25		0.90–2.60	0.87–2.53		0.80–1.11	0.75–1.02
Lives alone		1.10	1.11		1.75**	1.81**		1.00	1.01
		0.94–1.30	0.94–1.32		1.20–2.55	1.24–2.63		0.85–1.17	0.86–1.20
Widowed		1.33	1.33*		1.08	0.94		1.39*	1.40*
		0.99–1.79	1.03–1.71		0.48–2.43	0.38–2.34		1.04–1.86	1.08–1.81
Education		0.90**	.91**		0.78***	0.78***		0.93*	0.94
		0.84–0.96	0.85–0.97		0.69–0.87	0.70–0.87		0.86–0.99	0.88–1.00
Income		0.92***	0.93***		0.96	0.97		0.91***	0.92***
		0.90–0.93	0.91–0.94		0.91–1.01	0.92–1.02		0.90–0.93	0.91–0.93
Private medical insurance		1.10	1.08		0.81	0.79		1.20	1.19
		0.98–1.24	0.97–1.22		0.60–1.09	0.58–1.09		0.95–1.50	0.95–1.48
Medicaid		1.48***	1.41**		1.83*	1.67		1.41***	1.35**
		1.19–1.83	1.15–1.73		1.07–3.12	1.00–2.77		1.17–1.71	1.13–1.60

Independent Variable	Total Sample			Age < 50			Age ≥ 50		
	Model 1 (N = 6,529)	Model 2 (N = 6,497)	Model 3 (N = 6,497)	Model 1 (N = 3,258)	Model 2 (N = 3,243)	Model 3 (N = 3,243)	Model 1 (N = 3,271)	Model 2 (N = 3,254)	Model 3 (N = 3,254)
Regular physician		1.03	0.96		1.31*	1.26		0.96	0.89
		0.94–1.13	0.87–1.05		1.03–1.68	0.98–1.61		0.85–1.09	0.79–1.00
Smoker		1.40***	1.42***		1.56*	1.62*		1.34***	1.36***
		1.24–1.56	1.27–1.59		1.04–2.32	1.06–2.45		1.21–1.48	1.22–1.52
Past smoker		1.11**	1.11**		1.41**	1.40**		1.05	1.05
		1.03–1.20	1.03–1.20		1.15–1.74	1.13–1.73		0.96–1.15	0.96–1.14
Regular exercise		0.68***	0.72***		0.93	1.09		0.63***	0.65***
		0.57–0.81	0.62–0.83		0.57–1.50	0.70–1.72		0.51–0.78	0.54–0.79
Heart failure			1.61***			1.75**			1.63***
			1.37–1.89			1.25–2.45			1.36–1.95
Hypertension			1.36***			1.62***			1.33***
			1.21–1.54			1.30–2.03			1.20–1.49
Diabetes			1.61***			2.22***			1.59***
			1.38–1.89			1.48–3.35			1.31–1.93
Cancer			1.77***			2.39			1.69***
			1.39–2.26			0.88–6.53			1.35–2.12
Nonserious illness			1.00			0.88			1.01
			0.88–1.14			0.51–1.53			0.93–1.11
2 log likelihood	26624.8	25973.35	25828.11	4266.46	4057.95	4030.59	23741.33	23205.64	23061.73
df	4	16	21	3	15	20	3	15	20

^aRisk ratio.

^b95% confidence interval.

^cNormal weight (body mass index 18.5 & < 25) is the reference group.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Risk of Ischemic Heart Disease Mortality for Total Sample and by Age Categories With and Without Controlling for Heart Trouble at Baseline: National Health and Nutrition Examination Survey: Epidemiologic Follow-Up Study, 1971–1992

TABLE 3

Independent Variable	Ischemic Heart Disease (410–414.9)					
	Total Sample		Age < 50		Age 50	
	Model 1 (N = 5,117)	Model 2 (N = 5,117)	Model 1 (N = 3,016)	Model 2 (N = 3,016)	Model 1 (N = 2,101)	Model 2 (N = 2,101)
Age (50 years and older)	6.22 *** ^a	5.95 ***				
	4.28–9.03 ^b	4.27–8.29				
Underweight (BMI < 18.5) ^c	1.55	1.57 *	1.42	1.34	1.57 *	1.63 *
	0.98–2.45	1.05–2.36	0.57–3.54	0.49–3.64	1.04–2.35	1.12–2.39
Overweight (BMI 25 & < 30)	0.92	0.93	0.86	.88	0.91	0.92
	0.67–1.27	0.70–1.24	0.32–2.36	0.33–2.37	0.74–1.12	0.77–1.10
Obese (BMI ≥ 30)	1.50 **	1.47 *	1.99 **	1.96 *	1.35 *	1.31 *
	1.12–2.01	1.05–2.05	1.21–3.28	1.15–3.35	1.07–1.71	1.01–1.70
Female	0.37 ***	0.37 ***	0.25 **	0.25 **	0.39 ***	0.39 ***
	0.30–0.45	0.32–0.34	0.10–0.61	0.10–0.61	0.30–0.49	0.33–0.47
Black	0.52 ***	0.52 ***	0.69	0.74	0.48 ***	0.48 ***
	0.36–0.73	0.36–0.74	0.27–1.80	0.28–1.95	0.33–0.70	0.33–0.70
Lives alone	1.00	0.99	1.38	1.34	0.93	0.93
	0.80–1.25	0.78–1.27	0.54–3.49	0.52–3.44	0.73–1.20	0.71–1.22
Widowed	1.88 **	1.82 **	1.00	1.00	1.92 *	1.86 *
	1.24–2.83	1.23–2.67	0.54–1.10	0.51–1.04	1.17–3.17	1.14–3.05
Education	0.86 **	0.87 **	0.82	0.83	0.88 ***	0.89 **
	0.79–0.94	0.80–0.95	0.65–1.03	0.66–1.06	0.82–0.94	0.83–0.96
Income	0.92 ***	0.92 ***	1.05	1.04	0.90 ***	0.91 ***
	0.88–0.96	0.89–0.96	0.95–1.16	0.94–1.15	0.86–0.94	0.87–0.95
Private medical insurance	1.06	1.03	0.55	0.54	1.24	1.20
	0.89–1.26	0.86–1.23	0.28–1.06	0.28–1.06	0.91–1.70	0.90–1.61
Medicaid	1.93 ***	1.98 ***	3.55	3.35	1.80 ***	1.83 ***

Independent Variable	Ischemic Heart Disease (410–414.9)							
	Total Sample		Age < 50		Age 50			
	Model 1 (N = 5,117)	Model 2 (N = 5,117)	Model 1 (N = 3,016)	Model 2 (N = 3,016)	Model 1 (N = 2,101)	Model 2 (N = 2,101)	Model 1 (N = 2,101)	Model 2 (N = 2,101)
Regular physician	1.48–2.52	1.52–2.57	0.76–16.51	0.76–14.69	1.44–2.25	1.46–2.28		
	1.12	1.13	2.10	2.09	0.95	0.96		
Smoker	0.88–1.42	0.85–1.50	0.98–4.51	0.99–4.42	0.78–1.17	0.75–1.22		
	1.45*	1.40	1.86	1.88	1.36**	1.30*		
Past smoker	1.05–1.99	0.97–2.01	0.57–6.07	0.57–6.24	1.09–1.70	1.02–1.66		
	1.28**	1.26**	2.24***	2.31***	1.14	1.12		
Regular exercise	1.07–1.53	1.07–1.48	1.57–3.21	1.60–3.31	0.93–1.41	0.93–1.34		
	0.56***	0.63***	0.89	0.99	0.53**	0.60***		
Heart failure	0.42–0.75	0.50–0.80	0.32–2.48	0.31–3.12	0.36–0.76	0.45–0.80		
	2.24***	2.24***	2.11	2.11	2.30***	2.30***		
Hypertension	2.06***	1.88***	2.27*	2.17*	2.06***	1.86***		
	1.69–2.50	1.50–2.36	1.14–4.55	1.03–4.59	1.72–2.47	1.53–2.26		
Diabetes	2.27***	1.93***	4.43*	4.00*	2.06***	1.75***		
	1.77–2.91	1.54–2.41	1.20–16.45	1.10–14.58	1.63–2.61	1.33–2.30		
Cancer	1.15	1.18	2.54	2.44	1.07	1.08		
	0.73–1.83	0.80–1.73	0.56–11.56	0.46–12.91	0.70–1.65	0.76–1.54		
Nonserious illness	1.13	1.08	1.98	1.95	1.04	0.99		
	0.91–1.42	0.88–1.33	0.98–3.99	0.97–3.91	0.91–1.19	0.87–1.13		
2 log likelihood	6802.66	6764.82	1017.54	1015.28	6185.24	6142.76		
df	20	21	19	20	19	20		

^a Risk ratio.

^b 95% confidence interval.

^c Normal weight (body mass index 18.5 & < 25) is the reference group.

* $p < .05$

** $p < .01$

 $p < .001$

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

TABLE 4

The Association Between Obesity and Ischemic Heart Disease Mortality Among Respondents Free of Heart Trouble at Baseline for Total Sample and by Age Categories: National Health and Nutrition Examination Survey: Epidemiologic Follow-Up Study, 1971–1992

Independent Variable	Ischemic Heart Disease (410–414.9)		
	Total (N = 4,828)	Age < 50 (N = 2,943)	Age ≥ 50 (N = 1,885)
Age (50 years and older)	5.78 *** ^a 3.81–8.79 ^b		
Underweight (BMI < 18.5) ^c	1.51 0.76–3.01	1.92 0.78–4.77	1.39 0.79–2.43
Overweight (BMI ≥ 25 & < 30)	1.02 0.71–1.47	1.02 0.44–2.38	0.98 0.74–1.30
Obese (BMI ≥ 30)	1.73 * 1.07–2.81	2.56 *** 1.64–3.98	1.50 0.91–2.47
Female	0.37 *** 0.27–0.51	0.26 ** 0.10–0.66	0.39 *** 0.29–0.53
Black	0.54 ** 0.35–0.83	0.73 0.30–1.80	0.48 * 0.28–0.84
Lives alone	1.07 0.86–1.34	1.64 0.70–3.84	0.97 0.75–1.26
Widowed	2.08 *** 1.46–2.97	1.00 0.80–2.50	2.11 *** 1.39–3.21
Education	0.88 0.77–1.00	0.82 0.63–1.06	0.90 0.80–1.01
Income	0.90 ** 0.84–0.97	1.09 0.96–1.23	0.88 ** 0.81–0.95
Private medical insurance	0.98 0.80–1.20	0.54 0.24–1.22	1.13 0.75–1.70
Medicaid	1.72 *** 1.22–2.42	3.77 0.63–22.76	1.62 ** 1.21–2.17
Regular physician	1.06 0.83–1.37	1.92 0.94–3.92	0.90 0.71–1.13
Smoker	1.45 0.93–2.27	1.85 0.65–5.27	1.34 0.91–1.97
Past smoker	1.27 * 1.03–1.56	2.19 *** 1.49–3.23	1.09 0.84–1.41
Regular exercise	0.50 *** 0.36–0.69	0.72 0.28–1.84	0.45 *** 0.30–0.68
Hypertension	1.92 *** 1.49–2.48	2.54 ** 1.28–5.04	1.87 *** 1.45–2.40

Independent Variable	Ischemic Heart Disease (410–414.9)		
	Total (N = 4,828)	Age < 50 (N = 2,943)	Age 50 (N = 1,885)
Diabetes	2.25 ** 1.41–3.60	4.14 0.71–24.05	2.02 *** 1.53–2.68
Cancer	1.14 0.56–2.31	3.22 0.77–13.41	1.05 0.49–2.23
Nonserious illness	1.06 0.74–1.52	1.82 0.76–4.37	0.97 0.76–1.23
2 log likelihood	5244.90	924.28	4578.27
df	20	19	19

^aRisk ratio.

^b95% confidence interval.

^cNormal weight (body mass index 18.5 & 25) is the reference group.

*
 $p < .05$.

**
 $p < .01$.

 $p < .001$.