ISSN 1084-1695

Aging Studies Program Paper No. 21

Association between Body Size and Mortality in Later Life

Christine L. Himes

Center for Policy Research
Maxwell School of Citizenship and Public Affairs
Syracuse University
426 Eggers Hall
Syracuse, New York 13244-1020
(315) 443-3114 | Fax (315) 443-1081
e-mail: ctrpol@syr.edu

June 2000

$5.00

CENTER FOR POLICY RESEARCH – Spring 2000

Timothy M. Smeeding, Director
Professor of Economics & Public Administration

Associate Directors

Margaret M. Austin
Associate Director,
Budget and Administration

Douglas Holtz-Eakin
Chair, Professor of Economics
Associate Director, Center for Policy Research

Douglas Wolf
Professor of Public Administration
Associate Director, Aging Studies Program

John Yinger
Professor of Economics and Public Administration
Associate Director, Metropolitan Studies Program

SENIOR RESEARCH ASSOCIATES

Dan Black....................Economics
Stacy Dickert-Conlin....................Economics
William Duncombe....................Public Administration
Thomas Dunn....................Economics
Gary Engelhardt....................Economics
Deborah Freund....................Public Administration
Vernon Greene....................Public Administration
Leah Gutierrez....................Public Administration
Madonna Harrington Meyer....................Sociology
Christine Himes....................Sociology
Jacqueline Johnson....................Sociology
Bernard Jump....................Public Administration
Duke Kao....................Economics
Eric Kingson....................Social Work
Thomas Kniesner....................Economics
Jeff Kubik....................Economics
Jerry Miner....................Economics
John Moran....................Economics
Jan Ondrich....................Economics
John Palmer....................Public Administration
Lori Ploutz-Snyder....................Health and Physical Education
Grant Reeher....................Political Science
Stuart Rosenthal....................Economics
Jodi Sandfort....................Public Administration
Michael Wasylenko....................Economics
Assata Zerai....................Sociology

GRADUATE ASSOCIATES

Matthew Andrews....................Public Administration
Yvonne Arsenault....................Public Administration
Reagan Baughman....................Economics
Robert Bifulco....................Public Administration
Christine Caffrey....................Sociology
Julie Dombrowski....................Sociology
Karla English....................Public Administration
Amy Ferraro....................Public Administration
Seth Giertz....................Economics
Andrzej Grodner....................Economics
Tess Heintze....................Public Administration
Pam Herd....................Sociology
Peter Howe....................Economics
Alyssa Hundrup....................Public Administration
Kwangho Jung....................Public Administration
Young Sun Kwon....................Economics
James Laditka....................Public Administration
Xin Li....................Economics
Donald Marples....................Economics
Neddy Matshalaga....................Sociology
Adriana Sandu....................Public Administration
Shalini Sharma....................Economics
Mehmet Serkan Tosun....................Economics
James Williamson....................Economics

STAFF

JoAnna Berger....................Receptionist
Martha Bonney....................Publications and Events Coordinator
Karen Cimilluca....................Librarian/Office Coordinator
Kati Foley....................Administrative Assistant, LIS
Esther Gray....................Administrative Secretary
Denise Paul....................Editorial Assistant, *NTJ*
Mary Santy....................Secretary
Debbie Tafel....................Secretary to the Director
Ann Wicks....................Administrative Secretary
Lobrenzo Wingo....................Computer Consultant

Abstract

The rising prevalence of obesity in the United States has focused attention on the health consequences of excess weight. Obesity is linked to many of the major causes of death in the United States, including heart disease, some types of cancer, strokes, diabetes, and atherosclerosis. However, the effects of body size on mortality and health among the elderly are much less clear. This paper extends our current understanding of the relationship between body size and mortality by using two nationally representative, longitudinal datasets of individuals at older ages. These analyses indicate that obesity may not contribute greatly to increased mortality risks after age 70. In fact, obesity may be somewhat protective and lower the risk of death. At younger ages, however, the effects of obesity tend to operate in the opposite direction. Women especially appear to be at greater risk of death in their 50s and 60s if they are overweight.

The rising prevalence of obesity in the United States has focused attention on the health consequences of excess weight. Obesity is consistently associated with a variety of diseases; heart disease (Harris et al. 1988; Kannel and Gordon 1979), diabetes (Van Itallie 1985), and some types of cancer (Garfinkel 1985). The first Federal guidelines on the evaluation and treatment of obesity, recently released by the National Heart, Lung, and Blood Institute (1998), advise clinicians to treat obesity in adults aggressively. Despite this attention to the problem, little is understood about the effects of obesity late in life. Meanwhile, the lengthening life expectancy of individuals has prompted demographers to study the age patterns of mortality at advanced ages (Coale and Kisker 1990; Himes, Preston, Condran 1994; Horiuchi and Wilmoth 1998). This paper extends our current understanding of the relationship between body size and mortality by using two nationally representative, longitudinal datasets of individuals at older ages. In this paper, I examine the current relationship between body size and mortality at older ages—is body size associated with risk of death at older ages? How does this relationship change with age?

Body Size and Mortality

Body fat is a normal and necessary part of the human body. Fat serves an important function as a store of energy that can be used by the body in response to metabolic demands. Obesity, however, is an excess of body fat. At the most basic level, obesity results from an imbalance between energy intake and energy expenditure. However, this imbalance may be the result, individually or in combination, of excess caloric intake, decreased physical activity, or metabolic disorders. Obesity can be defined as any degree of excess weight over an optimal range defined by height and weight tables or as excessive body fat (adiposity), which can be independent of weight.

The most standard measure of obesity used across all studies is the body mass index (BMI), calculated as weight for height squared. The National Heart, Lung, and Blood Institute (an institute within NIH) issued the first Federal guidelines on the evaluation and treatment of obesity. The Institute adopted stringent definitions of overweight, defined by a BMI of 25 to 29.9 kg/m^2, and obesity, defined by a BMI of 30 kg/m^2 or greater (National Heart, Lung, and Blood Institute 1998). Although no precise guideline is given for underweight individuals, a BMI of less than 18.5 kg/m^2 is considered by the WHO to represent chronic nutritional deficiencies.

Body size varies by sex, race, and socioeconomic class (Goldblatt, Moore, and Stunkard 1965; Kumanyika 1992; Stunkard and Sorenson 1993; Williamson 1993). Women are more likely than men to be both overweight and underweight, and to show the greatest changes in weight as they age. Blacks and Hispanics have a higher prevalence of overweight than do whites, especially among women. Social class appears to be related to body size in complex ways, with studies showing socioeconomic characteristics to be both a cause and an effect of body size. Most evidence points to a causal relationship between socioeconomic characteristics, poor health behaviors (poor diet, lack of exercise), and being overweight (Goldblatt, Moore, and Stunkard 1965; Stunkard and Sorenson 1993). However, studies of young adults have lent support to the notion that being overweight leads to lower educational attainment and income through discrimination and lower self-esteem (Gortmaker et al. 1993).

Some specific health behaviors are also linked to body size. Smoking has been shown to be clearly related to body size—lean individuals are more likely to be smokers than those of normal or excess weight. For instance, in the Framingham study, the percentage of male smokers in the most overweight group was about 55 percent compared to 80 percent in the lowest relative weight category (Garrison et al. 1983). Cigarette smoking appears to reduce body fat in a number of ways, including reduced caloric intake, increased metabolic rate, and an increased level of energy expenditure. Since smoking is also related to greater risk of mortality, smoking behavior becomes an important control in studies relating body size and mortality.

Based on the NHANES II standards, obesity in the population varies considerably across subgroups (Table 1). Over the time period covered by NHANES II (1976 to 1980), approximately 24 percent of the male population and 27 percent of the female population were overweight, and 8 percent of adult males and nearly 11 percent of adult females were severely overweight. Among blacks, however, 26 percent of males and nearly 45 percent of females were overweight. Nearly 20 percent of black women were considered severely overweight (Kuczmarski et al. 1994; Najjar and Rowland 1987). In addition, there appears to be a trend towards an increase in the prevalence of overweight adults in the population. Between NHANES II (1976-1980) and NHANES III (1988-1991), the proportion of the population considered overweight has increased from 26 percent to 34 percent. Among the oldest age group included in the NHANES studies, those aged 60 to 74, the prevalence of overweight increased from 26.8 percent to 40.9 percent for males and from 37.3 to 41.3 for females between NHANES II and NHANES III.

However, the NHANES surveys do not include data for persons over age 74. Therefore, the prevalence of overweight and trends in body size at very old ages are largely unknown. It is assumed that the trends observed in the younger population are also true at later ages. It appears that there are no population based studies comparing body size distributions at very old ages across time.

Obesity is linked to many of the major causes of death in the United States, including heart disease, some types of cancer, strokes, diabetes, and atherosclerosis (National Heart, Lung, and Blood Institute 1998; World Health Organization 1997). Despite quite convincing evidence that excess weight is a significant risk factor for disease and disability in middle adulthood, the effects of body size on mortality and health among the elderly are much less clear. The relationship between body size and mortality is often described as J- or U-shaped—individuals with extremely low BMI are at high risk of death and the mortality risk rises more gradually with increased BMI (Folsom et al. 1993; Harris et al. 1988; Manson et al. 1995). The optimal BMI associated with survival, however, appears to vary with age. Recent research has found that non-smoking middle-aged women enrolled in the Nurses' Health Study exhibited the lowest mortality at a BMI below 19.0 (Manson et al. 1995). In contrast, work using a large database from the American Cancer Society found that for healthy, non-smoking white women, the lowest risk of death was found at a BMI of approximately 22.0 for those aged 30 to 54, and at a BMI of approximately 24.0 for women aged 55 to 74 (Stevens et al. 1998). Stevens et al. note that not only is there a level effect, but that the marginal effect of BMI on mortality was reduced with age as well; increases in BMI had a much smaller effect on mortality at older ages than younger ages. Allison et al. (1997), in an analysis of data from the Longitudinal Study of Aging, conclude that minimum mortality occurs at a BMI of approximately 31.7 for women and 28.8 for men, both in the range of BMIs considered to be "overweight" for adults in general. Similar results are found by Bender et al. (1999) in a study of German adults.

Recent work indicates that there may be a relationship between body size and mortality at ages over 65 (Stevens et al. 1998). However, this result is based on one particular study. With few exceptions, the majority of population level analyses of the relationship between body size and disability or mortality have been conducted using data from one of the three panels of the National Health and Nutrition Examination Survey, the Hispanic supplement to the NHANES, or the Epidemiological Followup Survey of the NHANES. The major drawback of these surveys is their limited coverage of persons 75 or older. As a result, we have very little information about the basic patterns and distributions of body size at older ages, and the relationship of body size to mortality at advanced ages.

Data and Methods

Data on height and weight are routinely collected in a number of large national surveys of the older population. For this project, I use two longitudinal surveys—the survey of Assets and Health Dynamics of the Oldest Old (AHEAD) and the Health and Retirement Survey (HRS). The AHEAD survey includes individuals aged 70 and older, while the initial population for the HRS is persons aged 50 to 62. The advantage of combining these two surveys is the coverage of nearly all ages over 50. Both surveys provide the data needed to estimate body mass index, some health behaviors, and socio-demographic factors. Combined, they provide information on age differences in body size distribution and in the relationship between body size and mortality risk.

The HRS study was designed to track the transitions in health and work status with age, as well as the accompanying changes in economic status and the use of public and private resources. The first wave of the survey was conducted in 1992 with a nationally representative sample of over 12,000 individuals. Of those respondents, 9,824 are considered "age eligible," that is born between the years of 1931 and 1941. The baseline interview includes a variety of questions on physical and mental health, physical functioning, family structure, income, and housing. A second wave of the survey was conducted in 1994 and a third wave in 1996.

The AHEAD study also was designed to track transitions in health and economic status with age (Soldo et al. 1997). The first wave of the survey was conducted in 1993-94 with a nationally representative sample of 7,430 individuals aged 70 or older. The target population is community-dwelling individuals born in 1923 or earlier; however, spouses of respondents outside of the target age range also are included in the sample (an additional 780 respondents). The baseline interview includes a variety of questions on physical and mental health, physical functioning, family structure, income, and housing. Additional waves were completed in 1996 and 1998. The analyses in this paper use data from the first and second wave of each survey.

In the analyses presented here, age, sex, and race are considered as controls for the relationship between body size and mortality. In the analysis, race will be categorized as white or non-white to explore the potential direct effects of race on mortality. Analyses are conducted separately for men and women due to the very different mortality and body size patterns of these two groups. Education, marital status, and smoking status are also controlled. Education is defined by years of completed education, currently married individuals are distinguished from the currently unmarried, and current and former smokers are distinguished from those who never smoked cigarettes.

Results

The two study populations differ in significant ways other than age (Table 2). The HRS age eligible population has an average age of 55.9, compared to 77.7 for the AHEAD group. Because of the higher mortality rates of men, both populations are more than half female; 53.2 percent of HRS respondents and 60.9 percent of AHEAD respondents. Additionally, the populations are primarily European Americans; 78.7 percent of the HRS respondents and 84.1 percent of LSOA respondents identify their race as white. Educational attainment improved dramatically between the two groups. Only 54.9 percent of the AHEAD respondents had a high school degree or higher, while over 70 percent of the HRS respondents had at least a high school degree. Being married is more common among HRS respondents (73 percent). The lower proportion married among the AHEAD population is again a reflection of higher male mortality leading to widowhood for older women.

In addition to these socio-demographic differences, the groups differ in their bodysize distribution. The mean BMI for the HRS population is higher than that for the AHEAD population (27.2 versus 25.4). This reflects the general loss of weight that accompanies aging. Using the new standards developed by the National Institutes of Health, nearly 65 percent of HRS respondents would be considered overweight or obese (BMI greater than 25). Among the AHEAD population, 49.3 percent would be considered overweight or obese. The proportion obese (BMI over 30) is about half that of the younger cohort (13.1 percent vs. 24.0 percent).

Figures 1 and 2 show graphically the changes in bodysize distribution with age. In Figure 1, the distribution of bodysize by age is plotted for HRS respondents. The age patterns are quite overlapping and have a longer right tail. The modal bodysize is roughly 26.0. A quite different age profile is seen for the AHEAD respondents. Each cohort within the AHEAD shows a shift to the left in the modal BMI, and the distribution is flatter than that seen in the HRS. The tail of the distribution is still long to the right, however the skewness of the distribution is much less. The shift in the distribution is particularly apparent after age 80.

The next step in the analysis investigates the extent to which obesity is related to higher mortality risks. First, simple two-year average BMI- and sex-specific death rates were calculated for the HRS and AHEAD groups. These rates represent the death rates between the first and second waves of each survey. In both populations, death rates are highest for those in the lowest body size category. All groups exhibit a tendency towards a U-shaped relationship, although that appears strongest in the AHEAD female population and weakest in the AHEAD male population.

Based on these patterns, it is clear that body size and mortality are not linearly related. To examine the relationship further I estimated logistic regression models with death as the outcome measure. Controls in the model include age, nonwhite race, years of completed education, and marital status. Since the HRS has relatively few deaths, the estimated models include all respondents in the HRS, regardless of age. Models based only on the age eligible population, as well as models based on any respondent over the age of 50 also were estimated. There results do not differ from those presented, although in the models for the age eligible population only, very few deaths (less than 10) remained after the second stage of the analysis.

A measure of smoking status is also included, since smoking is related both to body size and mortality. Models were estimated with current or former smokers combined as well as separate. There are no appreciable differences in results, and the models presented include both current and former smokers. Since the relationship between BMI and mortality appears to be non-linear, BMI was divided into three categories; less than 18.5, 18.5 to 29.9, and 30.0 or more. These cutpoints correspond to the accepted standards of undernutrition (18.5) and obesity (30.0). Since the BMI distribution changes with age, models were also estimated using cutpoints at the 10^{th} and 90^{th} percentiles based on the distributions of BMI by sex in each survey. The results from these cutpoints do not differ appreciably from those presented using the accepted standards.

Table 3 presents the results for these models. Controlling for other factors, increasing age is associated with increased chances of dying for all groups except women in the HRS. Since death rates are relatively low for women in this age range, risk factors, rather than age, seem to be the driving forces for mortality. Once other factors are controlled, nonwhite race has little effect on the risk of death. Only among women in the AHEAD sample is race significantly related to increased odds of death. In general, the increased years of education is related to lower mortality, although this effect was statistically significant only for women.

Marital status, measured as being currently married or not, is related to mortality in these samples in complex ways. Among men, being unmarried is related to a greater chance of death. This is true also for women in the HRS, but the opposite effect is seen among women in the AHEAD. Smoking, whether current or former, has a remarkably strong effect on death rates throughout. Smoking among men in the HRS in particular, where 29 percent of men are current smokers and 46 percent former smokers, is strongly related to mortality. In fact, 125 of the 141 men (89 percent) dying between waves of the HRS were current (64) or former smokers (61).

The two measures of body size indicate the importance of examining those at the extreme ends of the body size scale. Being underweight, a BMI of less than 18.5, greatly increases the odds of death for men and women in both the HRS and the AHEAD. However, being overweight, a BMI of 30.0 or more, is related only to increased mortality among women in the HRS. This suggests that body size operates differently by sex and age.

The effect of low BMI on mortality raises concerns of causality. At issue is whether it is a disease process that is leading both to a loss of weight and death. In Table 4, those individuals with a BMI of less than 20.0 (approximately the 10^{th} percentile for all groups), current and former smokers, and those who report their health as poor or fair are eliminated from the analyses. In this way, I hope to reduce the effects of disease on the mortality risks. These limitations greatly reduce the sample sizes for all groups; 89 percent of HRS men, 79 percent of HRS women, 86 percent of AHEAD men, and 64 percent of AHEAD women are eliminated from the analyses. The number of deaths also declines by 90, 74, 88, and 61 percent, respectively.

The results indicate among those who are healthy, women who are overweight in the HRS have increased risks of death. However, at older ages, increased body size is associated with lower risk of death for men. Among older women, increasing body size has no effect, positive or negative on mortality nor is there an effect among the younger men.

Discussion

Very little is known about the effects of obesity at older ages. While significant research has focused on the increased health risks under age 70 for those overweight, less attention has focused on the ways in which obesity may limit later life or later life functioning. The recently released Federal guidelines on the evaluation and treatment of obesity warn of the many health risks linked to the continued rise of obesity in the American population, but even they admit that little is known about the value of weight loss at very old ages (National Heart, Lung, and Blood Institute 1998). An understanding of this relationship is important for two very practical reasons—evaluating the importance of encouraging weight loss in late life and projecting the effects of increased population level obesity on later life health care needs. If excess weight is not associated with significant health problems in later life, then the value of weight loss at those ages is questionable. This is especially true if the relationship between mortality and obesity is less significant in later life than in the middle years.

These analyses indicate that obesity may not contribute greatly to increased mortality risks after age 70. In fact, obesity may be somewhat protective and lower the risk of death. Moderate excesses of fat may serve as a reserve for the older person in times of illness and may help sustain them through an acute illness. Another explanation might be built on the higher mortality at younger ages of those who are overweight. Obese individuals surviving to age 70 and beyond may be a select group with lower frailty, and this lower frailty is reflected in lower mortality at these older ages. At younger ages, however, the effects of obesity tend to operate in the opposite direction. Women especially appear to be at greater risk of death in their 50s and 60s if they are overweight.

Much has been made about the improving health status of the older population. One explanation often advanced is that the improved educational levels of the population have accounted for, and will continue to contribute to, this improvement (Freedman and Martin 1997; Preston 1992). But, to what extent will these improvements be limited by the concurrent trends in obesity? Several known forces are shaping the characteristics of the future elderly. Just as we can predict with some accuracy educational attainment, fertility histories, and employment histories, we have good information on health habits including cigarette smoking, drug use, diet, physical activity and body size. This information can be used to portray more accurately the health risks that will be faced in later life.

Acknowledgements

[*]Support for this research was provided by the National Institute on Aging (R01 AG14424-02), and from the Aging Studies Program and the Center for Demography and Economics of Aging, Syracuse University. The author is Professor of Sociology and Senior Research Associate, Center for Policy Research, The Maxwell School, Syracuse University.

References

Allison, D.B., M. Gallagher, F.X. Pi-Suyner, and S.B. Heymsfield. 1997. "Body Mass Index and All-Cause Mortality Among People Age 70 and Over: The Longitudinal Study of Aging," *International Journal of Obesity*, 21: 424-431.

Bender, R., K.H. Jockel, C. Trautner, M. Spraul, and M. Berger. 1999. "Effect of Age on Excess Mortality in Obesity," *Journal of the American Medical Association*, 281: 1498-1504.

Coale, A.J. and E.E. Kisker. 1990. "Defects in Data on Old-Age Mortality in the United States: New Procedures for Calculating Mortality Schedules and Life Tables at Highest Ages," *Asian and Pacific Population Forum*, 4: 1-31.

Folsom, A.R., S.A. Kaye, T.A. Sellers, C.P. Hong, J.R. Cerhan, J.D. Potter, and R.J. Prineas. 1993. "Body Fat Distribution and 5-Year Risk of Death in Older Women," *Journal of the American Medical Association*, 269: 483-487.

Freedman, V.A. and L.G. Martin. 1997. "The Role of Education in Explaining and Forecasting Trends in Functional Limitations among Older Americans." Paper presented at the 1997 Annual Meetings of the Gerontological Society of America, Cincinnati, OH.

Garfinkel, L. 1985. "Overweight and Cancer," *Annals of Internal Medicine*, 103: 1034-1036.

Garrison, R.J., M. Feinleib, W.P. Castelli, and P.M. McNamara. 1983. "Cigarette Smoking as a Confounder of the Relationship Between Relative Weight and Long Term Mortality. The Framingham Heart Study," *Journal of the American Medical Association*, 249: 2199-2023.

Goldblatt, P.B., M.E. Moore, and A.J. Stunkard. 1965. "Social Factors in Obesity," *Journal of the American Medical Association* 152: 1039-1042.

Gortmaker, S.L., A. Must, J.M. Perrin, A.M. Sobol, W.H. Dietz. 1993. "Social and Economic Consequences of Overweight in Adolescence and Young Adulthood," *New England Journal of Medicine*, 329: 1008-1012.

Harris, T., E.F. Cook, R. Garrison, M. Higgins, W. Kannel, and L. Goldman. 1988. "Body Mass Index and Mortality Among Nonsmoking Older Persons," *Journal of the American Medical Association*, 259: 1520-1524.

Himes, C.L., S.H. Preston, and G.A. Condran. 1994. "A Relational Model of Mortality at Older Ages in Low Mortality Countries," *Population Studies*, 48: 269-292.

Horiuchi, S. and J.R. Wilmoth. 1998. "Deceleration in the Age Pattern of Mortality at Older Ages," *Demography*, 35: 391-412.

Kannel, W.B. and T. Gordon. 1979. "Physiological and Medical Concomitants of Obesity: The Framingham Study." In G.A. Bray (ed.), *Obesity in America*. Washington, DC: National Institutes of Health.

Kuczmarski, R.J., K.M. Flegal, S.M. Campbell, and C.L. Johnson. 1994. "Increasing Prevalence of Overweight among US Adults: The National Health and Nutrition Examination Surveys, 1960 to 1991," *Journal of the American Medical Association*, 272: 205-211.

Kumanyika, S.K. 1992. "Special Issues Regarding Obesity in Minority Populations." Paper presented at the NIH Technology Assessment Conference: Methods for Voluntary Weight Loss and Control.

Manson, J.E., W.C. Willett, M.J. Stampfer, G.A. Colditz, D.J. Hunter, S.E. Hankinson, C.H. Hannekens, and F.E. Speizer. 1995. "Body Weight and Mortality Among Women," *New England Journal of Medicine*, 333: 677-685.

Najjar, M.F. and M. Rowland. 1987. *Anthropometric Reference Data and Prevalence of Overweight, United States, 1976-80,* Vital and Health Statistics, Series 11, No. 238. Washington, DC: Public Health Service.

National Heart, Lung, and Blood Institute. 1998. *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults*. Washington, DC: Public Health Service.

Preston, Samuel H. 1992. "Cohort Succession and the Future of the Oldest Old." In R.M. Suzman, D.P. Willis, and K.G. Manton (eds.), *The Oldest Old*. New York: Oxford University Press.

Soldo, B.J., M.D. Hurd, W.L. Rodgers, and R.B. Wallace. 1997. "Asset and Health Dynamics Among the Oldest Old: An Overview of the AHEAD Study," *Journals of Gerontology* (special issue) 52B: 1-20.

Stevens, J., J. Cai, E.R. Pamuk, D.F. Williamson, M.J. Thun, and J.L. Wood. 1998. "The Effect of Age on the Association Between Body-Mass Index and Mortality," *New England Journal of Medicine*, 338: 1-7.

Stunkard, A.J. and T.I.A. Sorenson. 1993. "Obesity and Socioeconomic Status—A Complex Relationship," *New England Journal of Medicine*, 329: 1036-1037.

Van Itallie, T.B. 1985. "Health Implications of Overweight and Obesity in the United States," *Annals of Internal Medicine*, 103: 983-988.

World Health Organization. 1997. *Obesity: Preventing and Managing the Global Epidemic.* Geneva: World Health Organization.

Williamson, D.F. 1993. "Descriptive Epidemiology of Body Weight and Weight Change in U.S. Adults," *Annals of Internal Medicine*, 119: 646-649.

Table 1. Prevalence of Overweight, United States Population (percent by study)

Population Group	NHES I[a] 1960-62	NHANES I 1971-74	NHANES II 1976-80	NHANES III 1988-91
Race/Sex[b]				
White men	23.0	23.8	24.2	32.0
White women	23.6	24.0	24.4	33.5
Black men	22.1	23.9	26.2	31.8
Black women	41.6	43.1	44.5	49.2
Sex/Age				
Men, Aged 50 to 59	28.8	27.1	28.2	42.1
Men, Aged 60 to 74	23.0	21.6	26.8	40.9
Women, Aged 50 to 59	35.0	35.5	36.5	52.0
Women, Aged 60 to 74	45.6	39.0	37.3	41.3

[a]National Health Examination Study
[b]Age adjusted
Source: Kuczmarski et al. 1994.

Table 2. Baseline Characteristics of AHEAD and HRS Populations

	HRS	AHEAD
Average age	55.9	77.7
Percent female	53.2	60.9
Percent white	78.7	84.1
Percent 12 or more years completed education	71.1	54.9
Percent married	73.1	48.5
Percent current or former smoker	63.4	51.0
Average BMI	27.2	25.4
Percent BMI under 18.5	1.4	5.0
Percent BMI 18.5 to 24.9	33.7	45.7
Percent BMI 25 to 29.9	40.9	36.2
Percent BMI 30+	24.0	13.1

Table 3. Logistic Regression Results for the Effects of Body Size on Mortality: HRS and AHEAD Populations

	HRS		AHEAD	
	Males	**Females**	**Males**	**Females**
Age	1.084**	1.026	1.071**	1.077**
Non-white	1.150	1.364	0.922	1.292*
Smoker	2.459**	1.794*	1.469*	1.303**
Education	0.965	0.923*	0.972	0.967*
Not Married	1.328	1.776*	1.786**	0.700**
BMI < 18.5	9.521**	5.669**	3.054**	2.013**
BMI > 30.0	1.019	1.604*	0.604	0.991
N	5,813	6,733	2,561	4,833
Deaths	141	86	276	512

*p<0.05
**p<0.01

Table 4. Logistic Regression Results for the Effects of Body Size on Mortality: HRS and AHEAD Healthy Populations (nonsmokers, BMI > 20.0, good health)

	HRS		AHEAD	
	Males	**Females**	**Males**	**Females**
Age	1.136**	1.047	1.094**	1.073**
Non-white	0.972	2.749	1.540	1.261
Education	0.940	1.038	1.009	0.974
Not Married	3.951*	1.872	1.991	0.617**
BMI	0.922	1.073*	0.783*	0.988
N	642	1,392	348	1,739
Deaths	14	22	34	202

*p<0.05
**p<0.01

Figure 1. Distribution of body size by age; HRS.

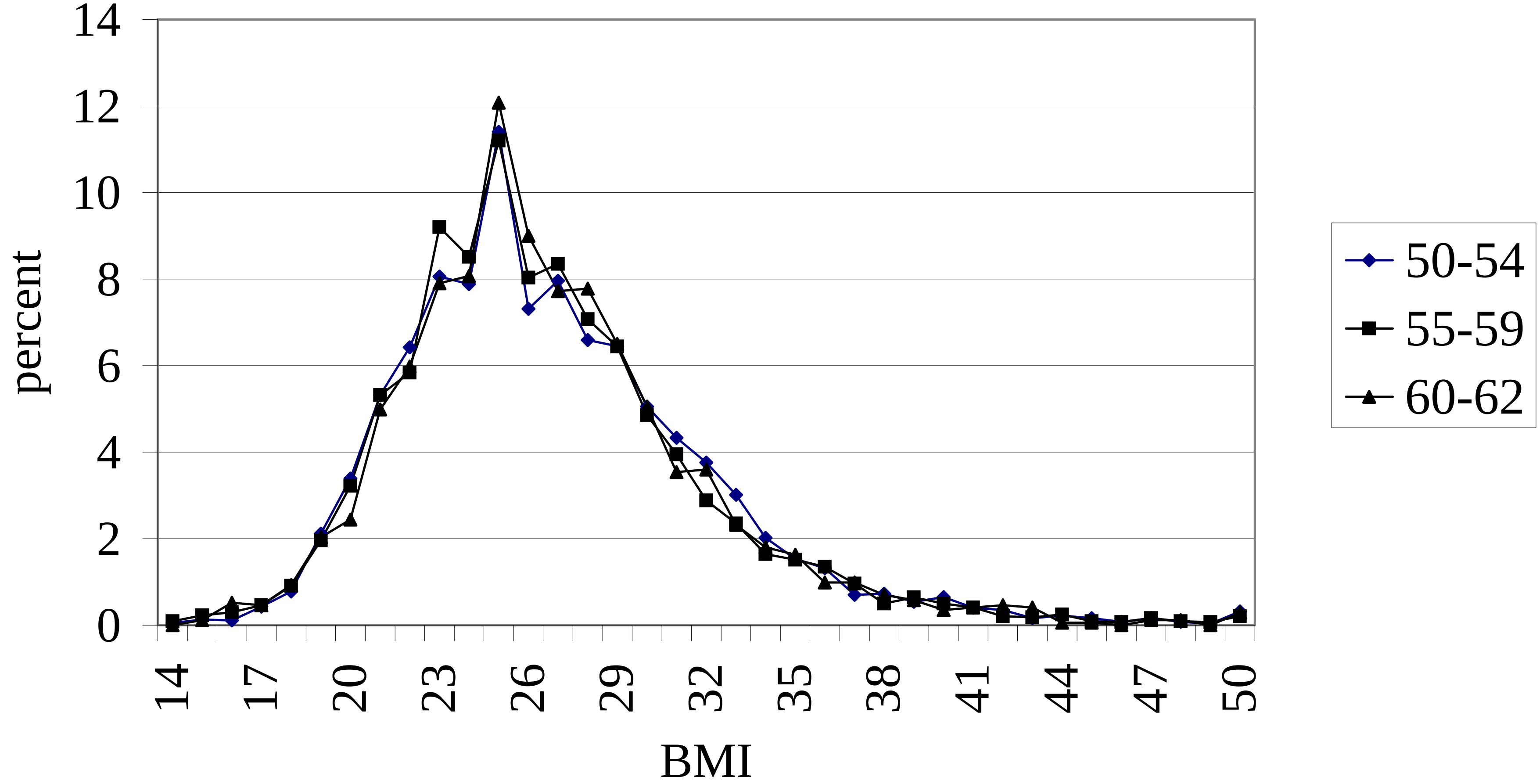

Figure 2: Distribution of body size by age; AHEAD.

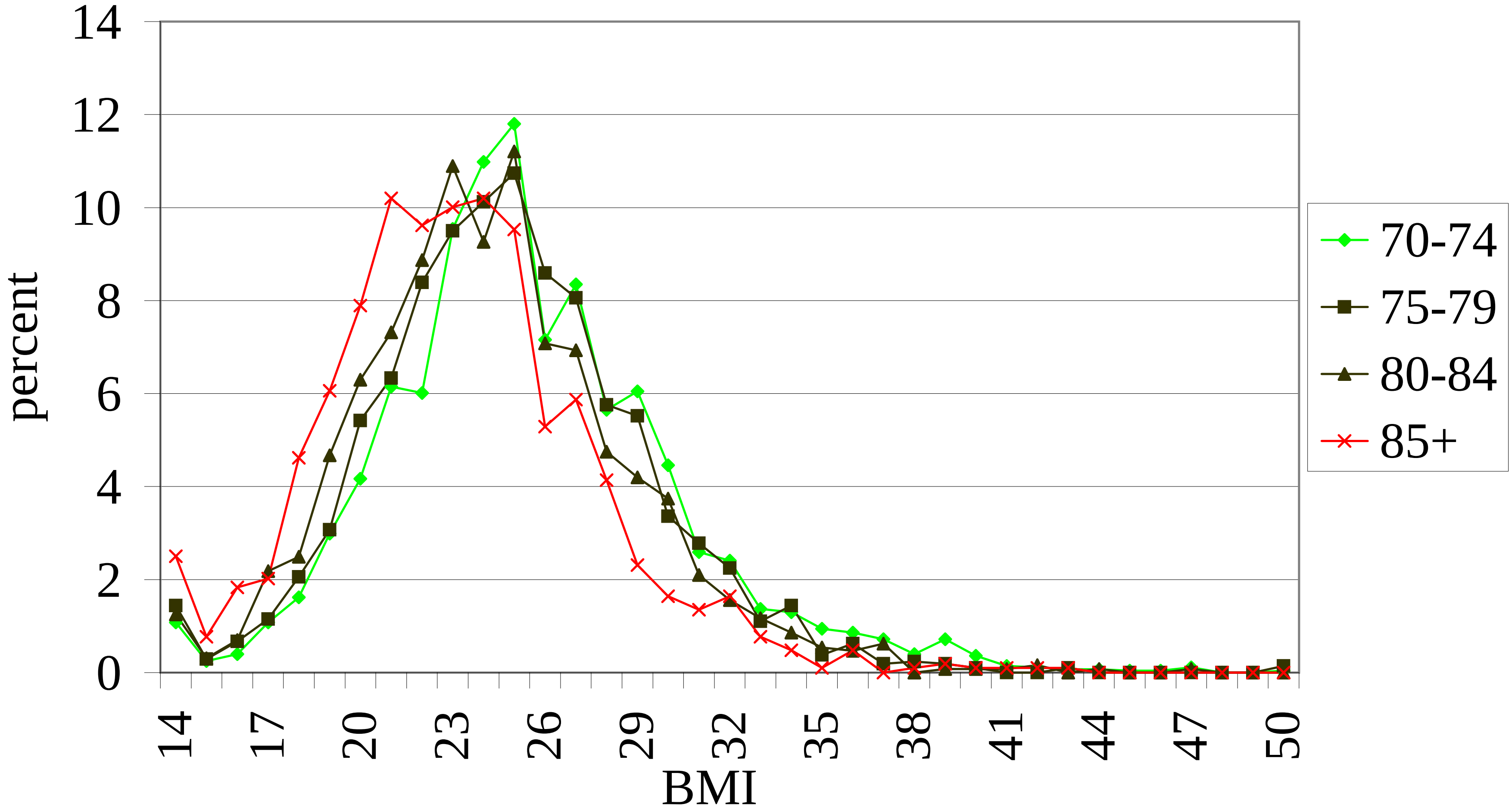

Figure 3. Body size by age; 50-54 and 85+.

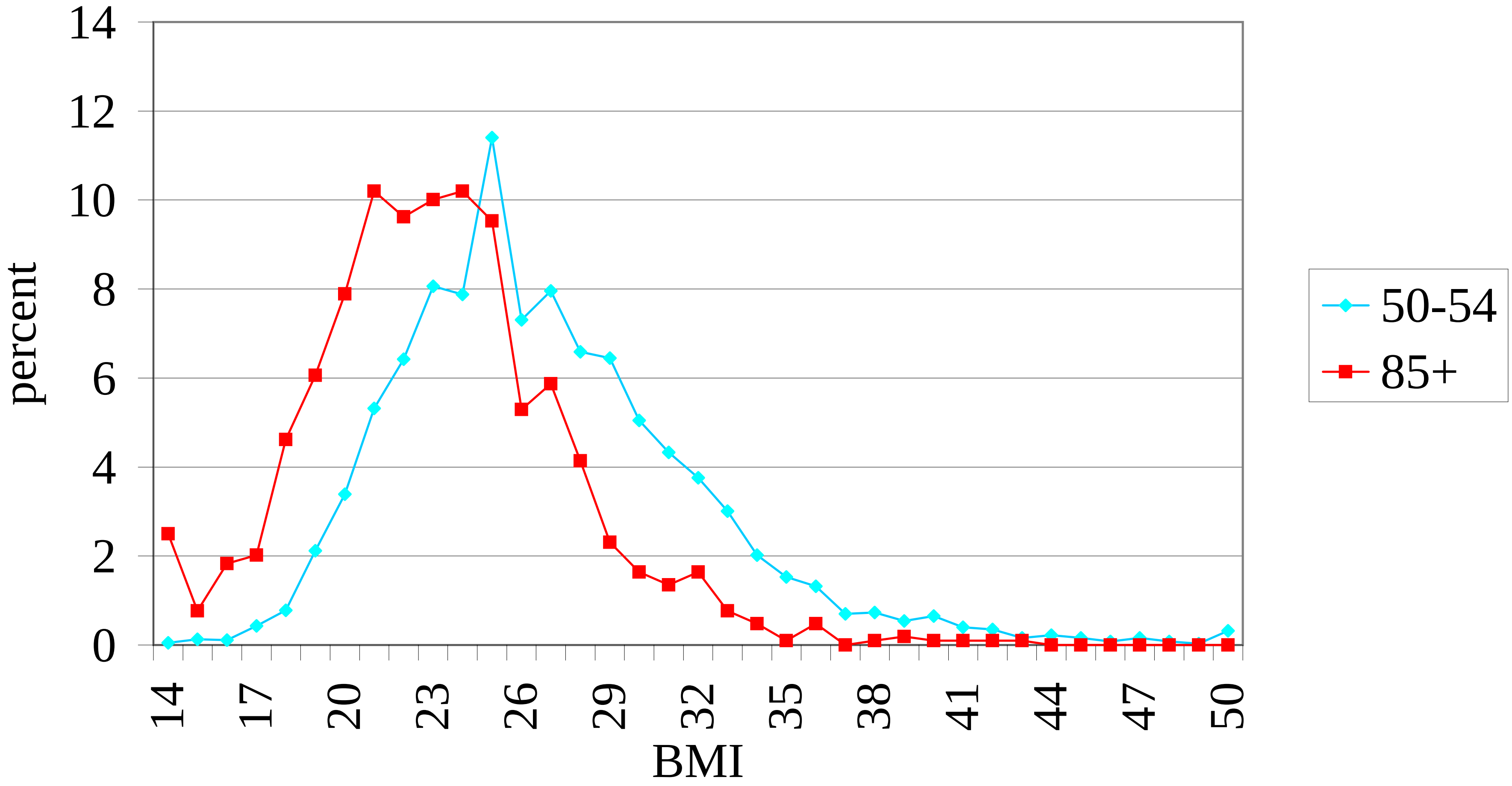

Figure 4. Death rates by BMI between waves 1 and 2; HRS.

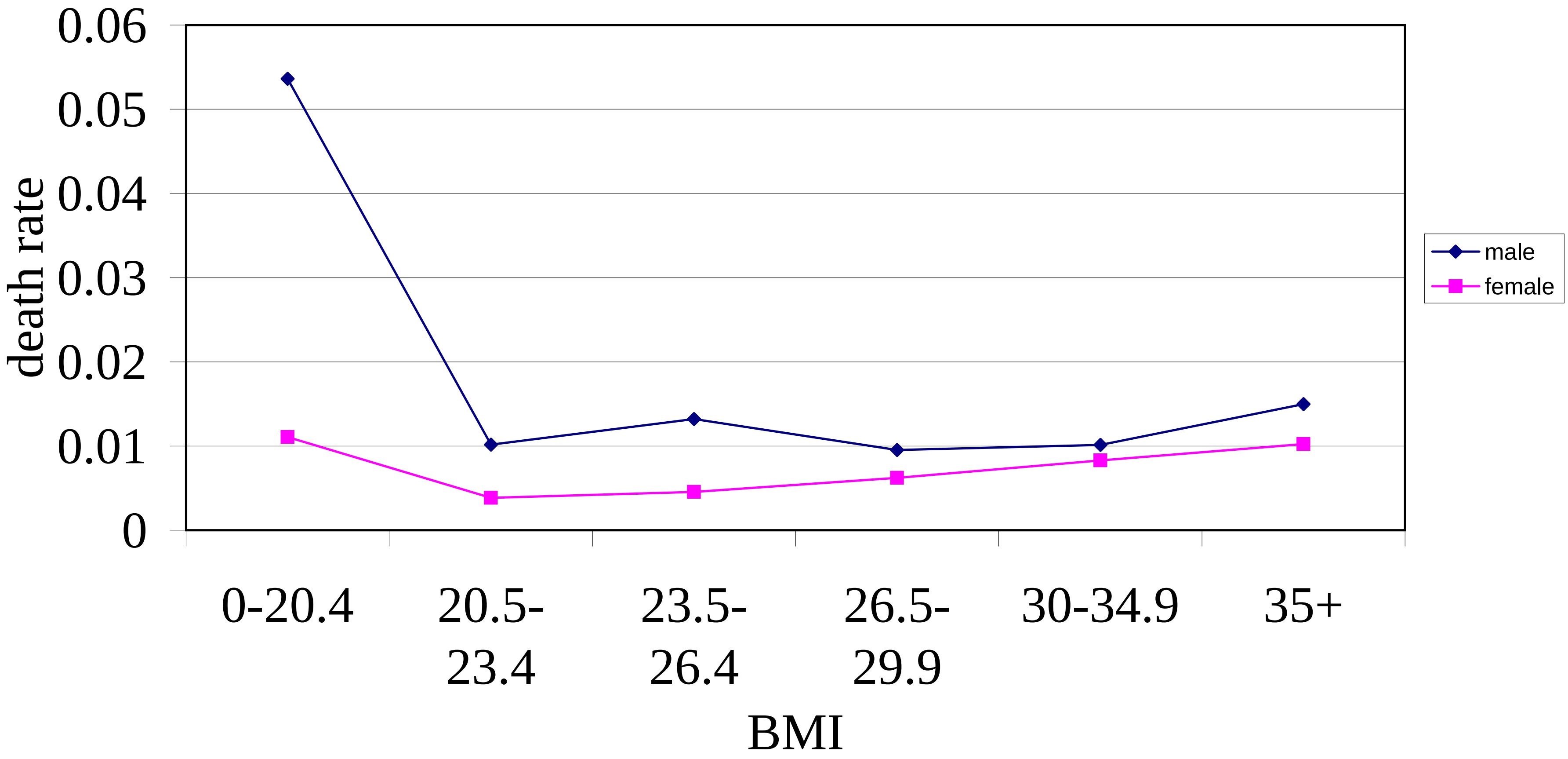

Figure 5. Death rates by BMI between waves 1 and 2; AHEAD.