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SOMATOTYPE, MORTALITY, AND MORBIDITY OF FORMER MICHIGAN STATE UNIVERSITY ATHLETES AND NONATHLETES

Michigan State University PH.D. 1986

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SOMATOTYPE, MORTALITY, AND MORBIDITY OF FORMER MICHIGAN STATE UNIVERSITY ATHLETES AND NONATHLETES

By

Bradley Ray Allan Wilson

A DISSERTATION

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ABSTRACT

SOMATOTYPE, MORTALITY, AND MORBIDITY OF FORMER
MICHIGAN STATE UNIVERSITY ATHLETES AND NONATHLETES

By

Bradley Ray Allan Wilson

The purpose of this study was to evaluate the effect of different measures of body build on mortality and morbidity. Somatotype, wt/ht, wt/ht^2 (body mass index), wt/ht^3, and $ht/\sqrt[3]{wt}$ (ponderal index) were considered.

Seven hundred sixty-seven subjects who had attended Michigan State University before 1938 were used for this study. This group consisted of 398 athletes and 369 nonathletes. A somatotype was predicted for each subject, and the four height/weight measures were calculated using height and weight while in college.

The analyses indicated that athletes were more mesomorphic and less ectomorphic than nonathletes. When longevity was considered, athleticism was not a good predictor. Somatotype, however, was a statistically significant predictor. The endomorphic group was shorter lived than the other three groups.

When the quantitative variables were compared, only wt/ht was a statistically significant predictor of longevity. When nonathletes

were considered, none of the height/weight variables was significant. Only in the athlete group was ht/wt a statistically significant predictor of longevity.

The relationship of somatotype and coronary artery disease (CAD) and cancer was also examined. No significant relationships were found in these limited data linking a specific somatotype group to CAD or cancer.

To my wife, Frances.

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CHAPTER I

THE PROBLEM

Studies that have investigated the effects of somatotype on mortality and morbidity have been limited in number and scope. Only one previous study (15) has considered somatotype and longevity in detail. It showed that men who lived to be 70, 75, or 80 years old were significantly less endomorphic ($p < .01$) when they were in college.

Several studies have been conducted that focused on somatotype and cause of death (16, 25, 67, 88, 90, 98, 99, 100), but these have been primarily limited to coronary artery disease (CAD). One investigation indicated the endomorphs as more likely to have CAD (67). Mesomorphs were more highly correlated with CAD in two studies (25, 99), and both endomorphs and mesomorphs were found to be at higher risk of CAD in three studies (16, 98, 100). Therefore, the somatotype which is most closely linked to CAD has not been clearly indicated at this time.

Somatotype is also a major consideration in the long list of athlete/nonathlete longevity studies. The reports from the three major studies have found inconsistent results. Paffenbarger et al. (63, 64) found that athletes were favored for longevity when they studied previous students from the University of Pennsylvania and Harvard

University. However, Polednak and Damon (74) and Polednak (70, 71, 72) found that major athletes were shortest lived when studying previous students from Harvard University. In the third major study, involving previous Michigan State University students, Montoye, Van Huss, and Nevai (55), Montoye et al. (56), Montoye (53), Olson et al. (61), and Olson (60) found no significant differences between the longevity of athletes and nonathletes. Since athletes tend to be more mesomorphic (9, 74), somatotype could have been the confounding variable in these studies (91, 92).

Several studies have been conducted to determine the best measure of body composition to use to predict longevity. One study determined that the body mass index, wt/ht^2 was a better predictor of mortality than relative weight (21). Two other studies found that mortality was higher at the upper and lower extremes of the indexes considered. One study used the ponderal index (89), and the other used wt/ht^2 (107).

When body composition indexes were used to predict CAD, little consistency was found. Three studies using male subjects found no good predictors of CAD (42, 45, 48). However, three other studies found wt/ht^2 to be associated with the development of CAD (11, 32, 78). In several studies conducted by Paffenbarger and associates, relationships between CAD and ponderal index (63, 65) and $wt/ht^2 \times 1000$ (62) were found. Two problems existed. First, these studies were not compared with somatotype to determine if somatotype was a better method. Second, no good evidence was shown to specify any measure as a good predictor of longevity.

Statement of the Problem

The purpose of this study was to determine the effects of somatotype on mortality and morbidity. The somatotypes were determined by using height and weight data obtained from a set of four questionnaires from the 1952 Longevity and Morbidity of College Athletes study. These weights and heights were used to calculate a ponderal index at each age the information was available for each subject. The ponderal indexes and ages for each individual were compared with the set of 88 somatotype weight-gain patterns presented in the Atlas of Men by Sheldon, Dupertuis, and McDermott (94) to arrive at a somatotype rating for that individual. Other measures of body composition were also calculated for comparison with somatotype.

This study was conducted in order to provide more information about the following issues:

1. Which somatotype grouping has the greatest mortality?

2. Which somatotype groupings are correlated with the different causes of death?

3. Does athletic status account for significant variation in longevity when considered with somatotype?

4. Which measure of body composition or body structure is the best predictor of mortality?

Significance of the Study

The results of this study provide insights into potential health problems of individuals based on their somatotype and body

composition. This information may help individuals determine and target behaviors that they will need to modify in order to prevent and intervene in specific health risks. It also identifies the value of other measurements of body composition in identifying risks. By determining the role of somatotype in longevity, this investigation adds information to the pool of knowledge relating to the athlete/nonathlete longevity studies.

Limitations of the Study

1. In the original survey in 1952 there was a large number of nonrespondents, which is a possible bias in the data.

2. The subjects were limited to male students who attended Michigan State University before 1938. Many of these individuals came from agricultural backgrounds, which is a source of bias.

3. Any subjects who died of war or catastrophic causes were deleted from the study.

4. The validity of the responses in a mailed questionnaire is a potential source of bias.

5. Because of the need for specific information, only subjects responding to the 1968 questionnaire were considered.

6. The method of classifying somatotypes has not been validated.

CHAPTER II

REVIEW OF LITERATURE

The major purpose of this study is to determine whether somatotype can be correlated with mortality or morbidity. Since the population that was tested consisted of athletes and nonathlete controls who graduated from Michigan State University, the first section is a summary of athlete longevity studies. Section two focuses on somatotype and mortality and somatotype and morbidity. Due to the difficulty of determining somatotypes, section three considers alternative methods of rating body structure or body composition.

Because of the limited data available from this longitudinal study, the reported height in 1960 must be used for the ages from 23 to 63. Therefore, a summary of height-decrement studies is included in section four.

The Longevity of Athletes

Many studies have been conducted that investigated whether or not participation in athletics increases the length of life. Two good reviews of these studies are available and were written by Poledńak (73) and Stephens et al. (101). Although many controlled studies have been completed, the evidence is not clear whether athletes or nonathlete controls have a favored longevity.

In the review presented by Stephens et al. (101), a summary of athlete longevity studies compared with population data was outlined (Table 2.1). Of the 17 studies, 16 favored greater athlete longevity. However, these studies were criticized for not using adequate control groups. Table 2.2 summarizes the athlete longevity studies conducted with control groups. Of these 15 reports, athletes were favored in three.

Four major studies utilizing control subjects have been reported. The initial investigation by Rook (80) in 1941 showed that honors men lived longer than athletes. Three more recent studies have been reported. Surveying pre-1938 Michigan State University lettermen and students, Montoye, Van Huss, and Neval (55), Montoye et al. (56), Montoye (53), Olson et al. (61), and Olson (60) found no significant differences between athletes and nonathletes. In general, nonathletes were favored but the differences were not significant. Paffenbarger et al. (63, 64) studied students and varsity athletes who attended the University of Pennsylvania and Harvard University between 1921 and 1950. These studies favored athletes for longevity. Polednak and Damon (74) and Polednak (70, 71, 72) researched major athletes, minor athletes, and nonathletes from Harvard University between 1880 and 1916. Major athletes were found to be the shortest lived. These three studies all found different conclusions.

In response to these athlete/nonathlete studies, Sheehan (91, 92) proposed that the major difference may be due to somatotype and not athletic competition. Carter (9) reviewed the different somatotypes of

Table 2.1.--Summary of athlete longevity studies: Comparisons with population data (From Stephens et al., 1984).

Investigator	Year	Examined Population	Number	Comparison Population	Findings	Comments
Morgan (57)	1873	1829-1859 Oxford and Cambridge University oarsmen	251	Dr. Farr's English Life Tables	Athletes favored	By 2.0 years
Meylan (51)	1904	1852-1892 Harvard University oarsmen	152	Standard mortality tables	Athletes favored	By 2.88 years
Gaines and Hunter (37)	1906	Pre-1905 Yale University athletes	Unspecified	Insurance tables	Athletes favored	Mortality ratio 49%
Anderson (2)	1916	1855-1905 Yale University athletes	808	Actuarial Society Table (AST) and American Table (AT)	Athletes favored	AST mortality ratio 52% AT mortality ratio 46%
Hill (35)	1927	1800-1888 British cricket players	3,424	English Life Table No. 4 and English Life Table No. 8	Athletes favored	Significant at all ages, all comparisons
Dublin (19)	1928	1890-1905 athletes from 10 eastern American colleges	4,976	Medico-Actuarial Table (MA) and American Men Table of Mortality (AMTM)	Athletes favored	MA mortality ratio 93.2% AMTM mortality ratio 91.5%
Reed and Love (79)	1931	1901 (in service)-1916 (commissioned before) West Point Military Academy officers	Unspecified (Total Study N=4,991)	American Men Table of Mortality and West Point officers	Athletes favored	By .25-1.25 years
Cooper, O'Sullivan and Hughes (12)	1937	Ormond College (Australia oarsmen)	100	Australian Insurance Table (AIT)	Athletes favored	Mortality ratio 75.4%

Table 2.1.--Continued.

Investigator	Year	Examined Population	Number	Comparison Population	Findings	Comments
Hartley and Llewellyn (31)	1939	1829-1928 Oxford and Cambridge University oarsmen	767	4 standard mortality tables (Hm, Qm, X_{Qm} + A, A)	Athletes favored	Period 1 mortality ratio 87.8% Period 2 mortality ratio 76.7% Period 3 mortality ratio 85.1% Period 4 mortality ratio 93.5%
Wakefield (108)	1944	1911-1935 Indiana high school basketball players	2,919	United States Bureau of Census life tables	Athletes favored	Mortality ratio 67.9%
Schmid (85)	1952	1861-1800 Czechoslovakian athletes	400	General population nonathletes	Athletes favored	By 8.66-1.44 years
Pomeroy and White (75)	1958	1900-1930 Harvard University football lettermen	424	1940 general Massachusetts population and other Harvard graduates	Unspecified	Athlete-population comparison not possible; coronary group engaged in less vigorous and habitual exercise
Karvonen (40)	1959	Pre-1930 Finnish champion skiers	388	1931-1940 and 1951-1955 general male Finnish population and 1949-1953 insurance population	Athletes favored	By 6-7 years over 1931-1940; smaller differences over 1951-1953; nonsignificant differences with insurance population
Pyorala et al. (77)	1967	Finnish long distance runners and skiers	93	Randomly selected Finnish population	Athletes favored	Have a higher degree of activity; mortality ratio-comparison not made
Schnohr (86, 87)	1971 1972	1880-1910 Danish champion athletes	297	General male population	Athletes favored	Mortality ratio to age 50, 61%; mortality ratio post age 50, 108-109%
Karvonen et al. (41)	1974	Finnish champion skiers born 1845-1910	396	General male population	Athletes favored	By 3-4 years
Metropolitan Life (50)	1975	1876-1973 major league baseball players	6,753	General population (white males) of the United States	Athletes favored	1876-1900 mortality ratio 103% 1901-1973 mortality ratio 71%

Table 2.2.--Summary of athlete longevity studies: Comparisons with control groups (From Stephens et al., 1984).

Investigator	Year	Examined Population	Number	Comparison Population	Number	Findings	Comments
Greenway and Hiscock (29)	1926	Post-1904 Yale University lettermen	686	1905-1923 Yale University non-lettermen	9,421	Controls favored controls 83% "Y" men 93%	Actual to expected deaths (%):
Dublin (20)	1932	1870-1905 eastern American college lettermen	4,976	1870-1905 eastern American college (B) lettermen	38,269	Honors men (controls) favored	Generally by 2 years--over both athletes and other students (nonsignificant)
Rook (80)	1941	1860-1900 Cambridge University athletes	722	1860-1900 Cambridge University honors and random graduates	374 (honors) 336 (random)	Honors men (controls) favored; random group (controls) no difference	Honors men by 1.5 years--over both athletes and other students
Montoye et al. (56)	1957	Pre-1938 Michigan State University lettermen	628	Pre-1938 Michigan State University students	563	No difference (in age at death)	122 deceased
Montoye et al. (55)	1962	Pre-1938 Michigan State University lettermen	628	Pre-1938 Michigan State University students	563	No difference (in age at death)	206 deceased
Montoye (54)	1967	Pre-1938 Michigan State University lettermen	628	Pre-1938 Michigan State University students	563	Nonathletes favored	By 2 years (nonsignificant)

Table 2.2.--Continued.

Investigator	Year	Examined Population	Number	Comparison Population	Number	Findings	Comments
Paffenbarger et al. (63)	1966	1921-1950 University of Pennsylvania and Harvard University varsity athletes	63	1921-1950 University of Pennsylvania and Harvard University students	590	Athletes favored (in coronary heart deaths)	Mortality ratio = .6
Paffenbarger et al. (64)	1967	1921-1950 University of Pennsylvania and Harvard University varsity athletes	118	1921-1950 University of Pennsylvania and Harvard University students	855	Athletes favored (in fatal stroke)	Mortality ratio = .4
Polednak and Damon (74)	1970	1880-1916 Harvard University lettermen (major athletes)	177	1880-1916 Harvard University students (minor and non-athletes)	275 (minor) 1638 (non)	Minor athletes favored	Major athletes shortest lived
Polednak (70, 71, 72)	1972	1880-1916 Harvard University lettermen (major athletes)	668	1880-1916 Harvard University students (minor and non-athletes)	1501 (minor) 4134 (non)	Minor athletes and nonathletes favored	By 1-3 years
Olson et al. (60)	1972	Pre-1938 Michigan State University lettermen	628	Pre-1938 Michigan State University students	563	Nonathletes favored	By 1.4 years (nonsignificant)
Prout (76)	1972	1882-1902 Harvard and Yale University crews	172	1882-1902 Harvard and Yale University students	172	Athletes favored	By 6.24-6.35 years (significant)
Olson et al. (61)	1978	Pre-1938 Michigan State University lettermen	628	Pre-1938 Michigan State University students	563	Nonathletes favored	By 1.86 years (nonsignificant)

athletes and has reported somatotype differences among the different sports. In general, the athletes were more mesomorphic. In a study by Polednak and Damon (74), athletes were found to be more mesomorphic and endomorphic than nonathletes. In order to identify whether athletic competition or somatotype is responsible for increased or decreased longevity, a controlled study comparing athletes and nonathletes with known somatotypes is needed.

Somatotype, Mortality, and Morbidity

Historically, science has had an interest in classifying humans by body structure. Hippocrates was the first scientist on record to develop a system of rating human physique (1, 83). Since his time in ancient Greece, many researchers have attempted to develop useful rating systems. The most widely accepted method in the United States was developed by W. H. Sheldon (93). His rating system focuses on three basic body types--endomorph, mesomorph, and ectomorph--which were derived from the three embryological layers--endoderm, mesoderm, and ectoderm, respectively. Each individual is rated on a scale from 1 to 7 in each of the three somatotypes.

Many European researchers have followed the system developed by Ernest Kretschmer. He preceded Sheldon and developed a method using three body types--pyknic, leptosome (later called asthenic), and athletic (47). The problem with Kretschmer's system is that it is limited to three body types. There is no continuous distribution of physiques as with Sheldon's system. Although the pyknics and endomorphs are similar, the asthenics and ectomorphs are similar, and the athletics

and mesomorphs are similar, these are very different rating systems and cannot be compared directly.

Initially the rating of somatotypes was used by psychologists. Then in 1951 Gertler et al. (25, 26) studied 100 patients between 23 and 40 years of age who had had a myocardial infarction. They found that the coronary artery disease (CAD) group was predominantly mesomorphic and contained few ectomorphic subjects (Table 2.3). This was followed by a postmortem study conducted by Spain, Bradess, and Huss (99). Their subjects included 111 consecutive deaths of white males under the age of 46. Of the 111, 38 had died of sudden myocardial infarction. This group of 38 contained 24 mesomorphs, 3 ectomorphs, 3 endomorphs, and 8 mixed. When considering the other 73 who had sudden violent deaths, a greater degree of CAD was found in dominant mesomorphs. These studies seem to indicate a greater risk of CAD by mesomorphs.

Table 2.3.--Physical groupings in the control group and the coronary disease group (From Gertler et al., 1951).

	Control Group (%)	CAD Group (%)
Endomorph	29	26
Mesomorph	19	42
Ectomorph	22	7
Others	30	25
Total	100	100

Conversely, Paul et al. (67) studied over 2,000 employees of the Hawthorne Works of the Western Electric Company and found dominance in the endomorphic component to be significant ($p < .01$) in coronary cases. In the same year (1963), Spain, Nathan, and Gellis (100) published a study on 5,000 white Jewish males between the ages of 36 and 65. They found endomesomorphs to be three times more likely to have CAD than ectomorphs. Using subjects from the Framingham Study, Damon et al. (16) compared 198 men with CAD and 1,427 men without CAD. The men with CAD were more endomorphic and mesomorphic. The men without CAD were more ectomorphic. These studies tend to include endomorphs with the mesomorphs for increased risk of CAD.

In another postmortem study by Spain, Bradess, and Greenblatt (98), mesomorphy, endomorphy, and mixed were all positively correlated with CAD. Only the ectomorphs did not correlate. This study agrees with the others that ectomorphs are less likely to suffer from CAD.

A similar study was conducted on CAD in Germany by Schonfelder and Zschoch (88). Using Kretschmer's categories of body structure, they found moderate and severe CAD to be more frequent in pyknic individuals than athletic and leptosome individuals (Table 2.4). Pyknics also suffered more acute infarcts and coronary insufficiency, while athletics and leptosomes survived primary myocardial infarctions better than the pyknics. This study implicates individuals with large amounts of body fat as more prone to CAD than individuals with a large muscle mass.

Table 2.4.--Frequency of coronary atherosclerosis and myocardial infarction of three constitution types in percentage of the total of the respective groups (From Schönfelder & Zschoch, 1967).

	Leptosome						Athletic						Pyknic					
	Male		Female		Total		Male		Female		Total		Male		Female		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total number of cases	128	100.0	55	100.0	83	100.0	145	100.0	106	100.0	251	100.0	260	100.0	356	100.0	616	100.0
Without coronary atherosclerosis	10	7.8	12	21.8	22	12.0	8	5.5	22	20.7	30	11.9	7	2.6	44	12.3	51	8.2
Light coronary atherosclerosis	56	43.7	33	60.0	89	48.6	47	32.4	57	53.7	104	41.4	95	36.5	190	53.3	285	46.2
Heavy coronary atherosclerosis	62	48.4	10	18.1	72	39.3	90	62.0	27	25.4	117	46.6	158	60.7	122	34.2	280	45.4
Myocardial infarcts	20	15.6	3	5.4	23	12.5	44	30.3	11	10.3	55	21.9	94	36.1	49	13.7	143	23.2
Fresh infarcts	2	1.5	1	1.8	3	1.6	11	7.5	--	--	11	4.3	33	12.6	21	5.8	54	8.7
Old infarcts	10	7.8	2	3.6	12	6.5	19	13.1	4	3.7	23	9.1	36	13.8	13	3.6	49	7.9
More mature infarcts	8	6.2	--	--	8	4.3	14	9.6	7	6.6	21	8.3	25	9.6	15	4.2	40	6.4
Fatal infarcts	11	8.5	1	1.8	12	6.5	26	17.9	7	6.6	33	13.1	56	21.5	34	9.5	90	14.6
Acute coronary insufficiency	1	0.7	--	--	1	0.5	2	1.3	--	--	2	0.7	6	2.3	3	0.8	9	1.4
Clinical hypertension	5	3.9	7	12.7	12	6.5	12	8.2	10	9.4	22	8.7	55	21.1	51	14.3	106	12.2

In a longevity study, Damon (15) looked at 2,450 previous students from Harvard University. He found that the men who lived to be 70, 75, or 80 years old were significantly less endomorphic ($p < .01$) when they were in college. These same individuals were also less mesomorphic, but this was not significant.

Several studies have been conducted that looked at the relationship between serum cholesterol levels and somatotype. Since elevated serum cholesterol has been linked to CAD (38, 39, 84), these studies can be related to the studies previously mentioned. In 1951 Tanner (104) studied serum cholesterol and physique. He found serum cholesterol levels to be correlated only to the endomorphic component. The serum cholesterol was related by 10.7 mg cholesterol for each unit rating in endomorphy. Gertler and White (27) studied 97 mesomorphs and 146 controls. The mesomorphs had more CAD proportionately, and among those with CAD mesomorphs had higher plasma cholesterol levels. Several years later Gertler et al. (28) found coronary-prone individuals to be more mesomorphic and also to have higher serum cholesterol levels. They also found coronary-prone individuals to be older, to be shorter, to have higher uric acid and phospholipid levels, to have higher blood pressures, and to have more mothers and fathers who had CAD. In 1967 Gertler (24) showed an association between mesomorphy and elevated serum cholesterol levels. He also showed a relationship between mesomorphy and ischemic heart disease. One investigation on lipid metabolism and somatotype was conducted on children in

Czechoslovakia. Among 414 children there were no differences in lipid metabolism between the different somatotypes of boys or girls (36).

Several studies considered the relationship between physique and tuberculosis (3, 8, 22). The ectomorphic component was most closely correlated with this infectious disease. This was grounds for Burr and Damon (7) to study the difference in eosinophil count with different physiques. No significant difference between eosinophil count and somatotype was found.

When considering the morbidity of the different somatotypes, Seltzer and Mayer (90) reported that mesomorphs and endomesomorphs are more susceptible to CAD, while the ectomorphs are more susceptible to tuberculosis. This is consistent with previous findings. Other relationships are shown in Table 2.5.

Table 2.5.--Somatotypes which are highly associated with selected diseases (Adapted from Seltzer & Mayer, 1966).

Disease	Somatotype
Tuberculosis	Ectomorph
Coronary artery disease	Mesomorph and endomesomorph
Osteoarthritis	Endomorph
Rheumatoid arthritis	Ectomorph and mesomorph
Gall bladder disease	Endomorphic mesomorph
Uterus cancer (women)	Endomorphic mesomorph
Breast cancer (women)	Endomorphic mesomorph
Endometrial cancer (women)	Endomorph
Meniere's disease (women)	Mesomorph
(men)	Endomorphic mesomorph
Obesity	Mesomorph and endomorph

Somatotype cannot be used as a sole predictor for mortality or morbidity. Evidence indicates that it may be useful in determining potential health problems that warrant appropriate intervention and prevention techniques. Tuberculosis is not a major health problem today; therefore, there is not a major health threat to ectomorphs. On the other hand, CAD is a major health problem in our society, and the mesomorphs and endomorphs should be aware of their higher-risk status.

Measures of Body Build

When considering mortality and morbidity, somatotype is frequently not determined. Somatotyping large numbers of subjects for these studies is both costly and time consuming. Many researchers have attempted to use other measures of body build to predict the longevity and cause of death of various groups.

Morris et al. (59) compared CAD in London bus drivers and conductors. They found the more active conductors to have less CAD than the more sedentary drivers. In a following study, Morris, Heady, and Raffle (58) found the drivers to have greater waist and chest circumferences. Therefore, it could be considered that body build may have a role in the incidence of CAD.

In 1959 the Society of Actuaries (95) presented data on over four million policy holders. They found that stocky, muscular men have shorter life expectancies than lean men. A similar investigation by Sorlie, Tavia, and Kannel (97) was conducted on subjects in the Framingham Study. Minimum mortality was found in subjects around average

weight. Persons weighing more or less than average had an increased mortality.

A couple of studies considered blood cholesterol levels with body build. Cerovska (10) examined 159 men and found those with elevated triglycerides to have greater skinfolds, greater body surface area, and greater abdominal circumference. On the other hand, those with elevated cholesterol levels had lower body surface area and lower fat-free body mass. Men with both elevated triglycerides and cholesterol only had increased body surface area in common. Focusing on younger subjects, ages 19 and 20 years of age, Hellstrom (33) showed that short, heavy individuals had higher cholesterol levels than tall, light individuals. Bjurulf (4) took this one step further and looked at body build and grade of CAD. The amount of muscle tissue and labile fat were good predictors of the grade of CAD, but skeletal dimensions were not.

The common problem with the studies considered so far in this section is that they were not presented in a usable, transferable format. In other words, they cannot be quantitatively compared with each other. Therefore, other indices must be considered.

To find which weight-height ratios could best be used in epidemiological studies, Florey (23) compared weight/height, weight/height squared (body mass index [BMI] or Quetelet's Index), and height/cube root of weight (ponderal index). Using data from the Framingham Study, he found that wt/ht^2 was the best index for measuring adiposity or body shape in males. This was followed by wt/ht, and the

ponderal index was considered the worst. Despite the fact that wt/ht^2 was found to be the best, it was still rated as a poor measure of adiposity. A similar investigation was conducted by Keys et al. (43). They evaluated the same three indices by correlating them with height and subcutaneous fat. Basing their research on 7,424 healthy men from five different countries, the wt/ht^2 was found to be the best index. As in the Florey study, the wt/ht was found to be the next best, with the ponderal index being the poorest. These two studies indicated that the wt/ht^2 is the best measure of body shape when only the heights and weights are known.

When considering mortality, the wt/ht^2 was a better predictor than relative weight. This was reported by Dyer et al. (21) after studying men of the Chicago People's Gas Company. Waaler (107) compared the wt/ht^2 to mortality on a Norwegian population. He found a U-shaped curve where mortality was higher with both low and high wt/ht^2 values. Morbidity was also considered and is summarized in Table 2.6.

Table 2.6.--Diseases which are highly associated with selected body characteristics (Adapted from Waaler, 1984).

Low Height	Low Weight	High Weight
Obstructive lung disease	Obstructive lung disease	Cardiovascular disease
Tuberculosis	Tuberculosis	Cerebrovascular disease
Stomach cancer	Stomach cancer	Diabetes
Lung cancer	Lung cancer	Colon cancer

Two other studies were done using the ponderal index as a predictor of mortality. In 1966 Seltzer (89) reported an increase in mortality with a decrease in ponderal index. Large increases in mortality were found when the ponderal index was 12.3 or lower, and dramatic increases in mortality were noticed when the ponderal index was less than 11.6 (Figure 2.1). Damon (15) measured the ponderal index of men in college and showed a significantly ($p < .01$) greater chance of reaching the ages of 70, 75, and 80 if the ponderal index was higher.

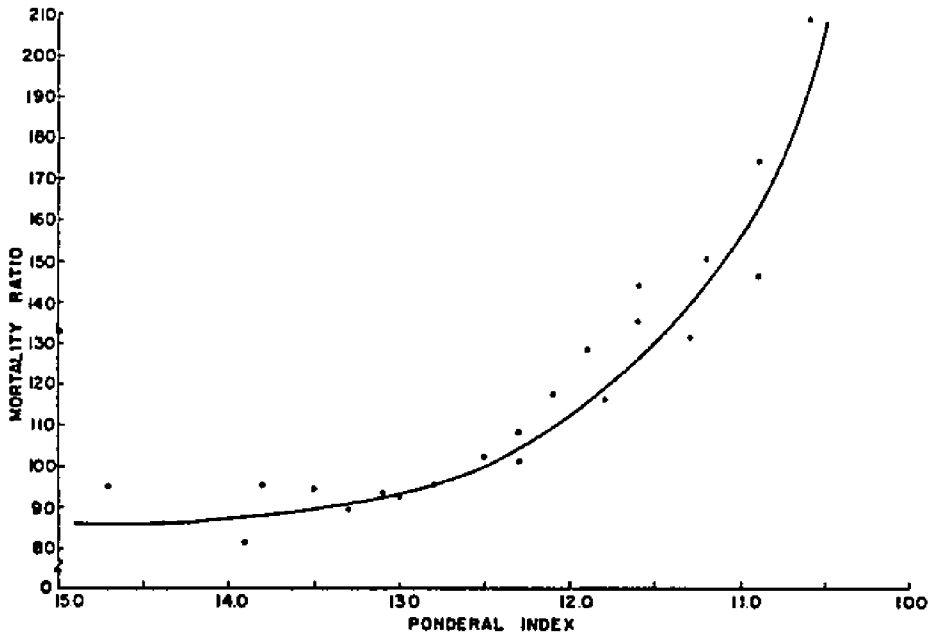


Figure 2.1.--Association of mortality ratio with ponderal index for men ages 40 to 49. (From Seltzer, 1966.)

When these indices were used as predictors for CAD, little consistency was found. Klein et al. (45) compared weight, wt/ht, wt/ht^2, $wt/ht^3 \times 10{,}000$, log wt/ht^2, average weight, and relative weight. All seven measures were considered poor predictors of CAD. Keys et al. (42) considered wt/ht^2 and weight as a percentage of the insurance average. These were also not determined good predictors of CAD. A similar study was conducted on 792 54-year-old men from Gothenburg, Sweden, by Larsson et al. (48). Again there was no correlation between wt/ht^2 and stroke, ischemic heart disease, or death. However, the waist-to-hip circumference ratio was significantly associated with all three. A similar study was conducted on 1,462 women between 38 and 60 from Gothenburg, Sweden. Lapidus et al. (47) found that wt/ht^2 was significantly correlated ($p < .05$) with myocardial infarction and ECG changes, suggesting ischemic heart disease. Despite the significant correlation, the waist-to-hip circumference ratio was a stronger predictor than wt/ht^2 for CAD.

On the other hand, data from the Manitoba Study presented by Rabkin, Mathewson, and Hsu (78) showed that the wt/ht^2 was significantly associated with the development of a myocardial infarction ($p < .05$), sudden death ($p < .01$), and coronary insufficiency ($p < .05$). Hawthorne and Womersley (32) studied 3,364 men in western Scotland. A linear relationship between wt/ht^2 and the death rate from CAD was found. In Czechoslovakia, Cerovska (11) measured 80 men who were admitted for diagnosis of myocardial infarction. When men with ischemic heart disease were compared with the men without the disease, two

differences were noted. $Wt/ht^2 \times 100$ was significantly ($p < .05$) higher and $wt/ht^3 \times 10{,}000$ was significantly ($p < .01$) higher in men without disease.

Paffenbarger and associates found the ponderal index and $wt/ht^2 \times 1000$ to be useful when predicting CAD. When comparing coronary descedants with controls of 45,000 past college students, Paffenbarger et al. (63) found a significant difference in the ponderal index of each group. Also a larger number of descedants had a ponderal index of 12.8 or less. In 1969 Paffenbarger and Wing (65) found a 30% increased risk of CAD in men with a ponderal index below 12.9 when studying former students from Harvard University and the University of Pennsylvania. Using only the 16,936 Harvard alumni who entered college between 1916 and 1950, Paffenbarger et al. (62) reported an inverse relationship between the $wt/ht^2 \times 1000$ and CAD. If this index was greater than 36, there was a 32% higher risk of CAD.

Two studies considered the relationship between the ponderal index and hypertension. Although Perera and Damon (68) found that women with higher ponderal index values had greater incidences of hypertension, no significant differences were found in men. Using subjects from the Bogalusa Heart Study, Voors et al. (106) found that children with higher ponderal indexes (wt/ht^3 was used in this study) had higher systolic and diastolic blood pressures.

Paffenbarger and Wing (66) used the ponderal index as a predictor for adult-onset diabetes. When weight increased, the ponderal index decreased and the incidence of diabetes was greater. In an

attempt to look at infection resistance, Burr and Damon (7) found no significant difference between eosinophil count and ponderal index.

The different body-build indices have not been shown to be good predictors of mortality and morbidity. The problem of separating body mass due to fat from body mass due to muscle is a clear problem. Ideally, alternative methods for predicting longevity and disease will be developed.

Height Decrement

The changes in the stature of man throughout life has been a topic of research in many studies. It is generally felt that humans increase in height, maintain peak height for some time, and then lose height. Of the many studies conducted, some were cross-sectional and some were longitudinal.

In a 1927 cross-sectional study, Ruger and Stoessiger (82) found a decrease in height with age. Similar results were reported by Pett and Ogilvie (69), Stoudt, Damon, and McFarland (102), and Stoudt et al. (103). A review of the Build and Blood Pressure Study by Brozek (5) reported that the 1.5 inch decrease in height between the 20-29 age group and the 60-69 age group was not totally due to individual decreases in stature but in part due to a generational increase in stature. In 1965 Damon (14) commented that "trends in aging are best determined by longitudinal rather than cross-sectional studies."

Trotter and Gelser (105) attempted to separate the age and secular factors. Using 855 cadavers they estimated that there was a

1.2 cm decrement over a 20-year period. This was a nonlinear function, and the decrement did not begin until after the age of 30. This study was followed by Hertzog, Garn, and Hempy (34), who tried to partition the effects of secular- and age-associated changes by using tibia length as a reference. In males they estimated that there was a 1.93 cm decrease in stature between the ages of 35 and 65 and another 1.19 cm decrease between the ages of 66 and 87. Although these studies attempted to consider the secular changes in height, longitudinal studies were still needed to verify these points.

Buchi (6) conducted a longitudinal study and found that the height decrement began at age 47. Measuring subjects over the age of 70, he determined the average lifetime decrement to be 2.9 cm. In another study using 44 retired British servicemen, Lipscomb and Parnell (49) found no height decrement by 72 years of age. This investigation was supported by a study by Kidera (44), who did not find any height change in 100 senior airline pilots between the ages of 30.5 and 50.5. However, two later studies agreed with Buchi and did find some height decrement. Gsell (30) studied several age groups for 10-year periods to find the average height decrements. He reported a decrement of 6 mm between ages 30 and 40, 14 mm between ages 40 and 50, and 17 mm between 50 and 60. This is equal to 37 mm between 30 and 60 years of age. Miall et al. (52) conducted a longitudinal study on height decrement in two Welsh communities. The data are presented in Table 2.7. The height decrement began after the age of 35 and totaled 7.1 cm by age 85

in one community and 4.6 cm in the other. The decrements to age 64 were 3.1 cm and 1.7 cm. Much of the height loss occurred after age 64.

Table 2.7.--Mean annual height decrements (mm) of males over decades from 25 to 85 years in two Welsh communities (From Miall et al., 1967).

Age Interval	Rhondda Fach	Vale of Glamorgan
25-34	-0.28	-0.40
35-44	0.71	0.16
45-54	1.05	0.52
55-65	1.38	1.01
65-74	1.46	1.49
75-85	2.46	1.43

After completing an aging study using 2,200 healthy male veterans, Damon et al. (17) concluded that the major height decrements in previous studies were due to a secular trend. Individual shrinkage occurs mostly after the sixth decade of life. In a review Rossman (81) concluded that individual height decrements are encountered after 50 years of age. The lifetime loss in males can be expected to average 2.9 cm.

The evidence on height decrement is not clear. It appears that there is a major secular trend toward taller people. Individual height decrements are negligible until the later years, and then small decreases can be expected.

Summary

The longevity of athletes when compared to nonathletes is not conclusive. One confounding variable may be somatotype. Since athletes tend to have a higher mesomorphic component, these studies may be comparing high-mesomorphic individuals with low-mesomorphic individuals. Therefore, controlling for physique may be important when considering the athlete/nonathlete longevity question.

Many alternative measures of physique have been studied. Although the wt/ht^2 seems to predict longevity the best, none of the indexes has been shown to be a good predictor. Therefore, the somatotyping of athletes and nonathletes may be necessary for these studies.

CHAPTER III

RESEARCH METHODS

This investigation was conducted to identify the effect of different body types on mortality and morbidity. Athletes were compared with nonathletes to determine if there was a difference in somatotype. Then the strength of somatotype and athleticism as predictors of longevity was considered, as well as the relationships among the various somatotype groups and longevity. Other predictors of mortality such as weight/height, weight/height squared, weight/height cubed, and height/cube root of weight (ponderal index) were also evaluated. Last, the relationships between somatotype-group membership and coronary artery disease and cancer were examined.

Source of Data

The subjects for this study were derived from a pool of male students who attended Michigan State University before 1938. All males who had won a varsity athletic letter for competition in intercollegiate sports before 1938 were included as the treatment group (Appendix A). The control group consisted of a random sample of previous students found in the student directory and matched with the athletes by class rank during the year the athlete won his first letter. The mean age difference between the two groups was less than .05 year. In 1952

a total of 2,258 subjects (1,129 athletes, 1,129 controls) were selected and sent a questionnaire (Appendix B). Six hundred twenty-five athletes and 557 nonathletes returned the first questionnaire for a return rate of 52.4%. Of this group, 67 athletes and 55 nonathletes were deceased.

A follow-up survey was conducted in 1960 (Appendix B). All living respondees from the 1952 survey were mailed questionnaires. The return rate was 91.7%, with 514 returns (92.1%) from athletes and 458 returns (91.4%) from controls. The deaths reported were 52 athletes and 32 nonathletes, leaving 888 subjects in the study.

The two following surveys, 1968 and 1976 (Appendix B), were conducted in a similar manner. The return rates were over 90%, with 128 and 167 deaths reported, respectively. These values are summarized in Table 3.1 along with all other survey data.

In 1984 the most recent survey (Appendix B) was mailed to the 457 remaining subjects who were not known to be deceased. Three hundred seventy-five surveys were returned, 199 from athletes and 176 from nonathletes, for a return rate of 90.4%. From this survey, 171 subjects were found to be deceased, including 93 athletes and 78 nonathletes (Table 3.1).

Selection of Sample

Due to the types of questions asked on the different questionnaires, subjects who did not respond to the 1968 survey had to be deleted because of insufficient information. Subjects who did respond to the 1968 questionnaire provided the information needed to predict

Table 3.1.--Overview of the Michigan State Longevity Study (Adapted from Olson et al., 1978).

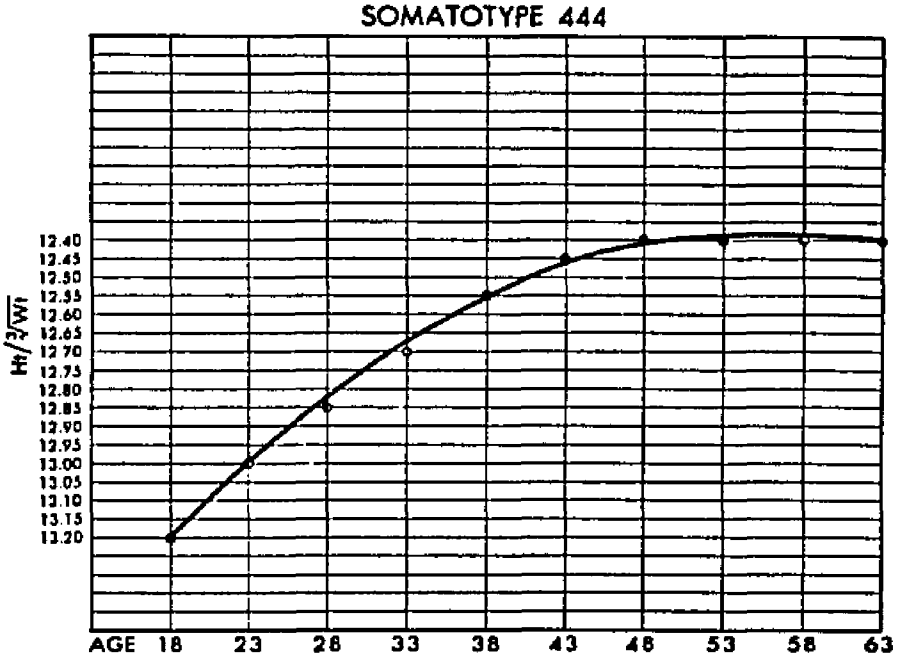
		Athletes	Nonathletes	Total
1952	Surveyed	1129	1129	2258
	Returned	625	557	1182
	% Returned	55.4	49.3	52.4
	Deceased	67	55	122
	Living	558	502	1060
1960	Surveyed	558	502	1060
	Returned	514	458	972
	% Returned	92.1	91.4	91.7
	Deceased	52	32	84
	Living	462	426	888
1968	Surveyed	490	452	942
	Returned	471	440	911
	% Returned	96.1	97.3	96.7
	Deceased	66	62	128
	Living	405	378	783
1976	Surveyed	392	359	751
	Returned	368	333	701
	% Returned	93.8	92.8	93.3
	Deceased	89	78	167
	Living	279	255	534
1984	Surveyed	243	214	457
	Returned	220	193	413
	% Returned	90.5	90.2	90.4
	Deceased	93	78	171
	Living	199	176	375

their somatotype, such as height, year of birth, weight at graduation, and weights at each year of the completed surveys. Sufficient data were collected on 767 subjects, and their somatotypes were predicted by the method described later. Unfortunately, not all of the cause-of-death data from the 1985 survey were available for analysis. Only two groups, coronary artery disease and cancer, were large enough to make comparisons.

Determination of Somatotypes

The somatotypes were predicted independently by three different investigators. The estimation of somatotype was made blind. None of the investigators knew the athletic status or whether the subjects were alive or deceased when predicting somatotype. After the somatotypes were determined, all three met as a group to come to a consensus on a somatotype for each subject. This system was used to maximize the reliability and objectivity of the method that was developed.

The method for predicting somatotypes used data reported by Sheldon et al. in Atlas of Men (94). Forty-six thousand men were used as subjects for this book. Each individual was somatotyped, and age, height, and weight were determined. There were 88 different somatotypes found. For each somatotype a graph was plotted with the ponderal index on the abscissa and age on the ordinate (Figure 3.1). These 88 graphs determined by Sheldon et al. (94) were used to predict somatotypes. Similar data and graphs were generated for each subject in this study. Then these data and graphs were compared with those presented in Atlas of Men (94).



Weight for Age and Height

Height (inches)	Age									
	18	23	28	33	38	43	48	53	58	63
75	183	192	198	206	212	219	220	220	221	221
74	176	184	190	198	204	210	211	212	212	212
73	169	177	183	190	196	202	203	204	204	204
72	163	170	176	183	189	194	195	195	196	196
71	155	163	168	175	180	185	187	187	187	187
70	149	156	162	168	173	178	179	179	180	180
69	143	150	155	161	166	170	172	172	172	172
68	137	143	148	154	159	163	165	165	165	165
67	131	137	142	147	152	156	157	157	158	158
66	125	131	135	140	145	149	150	150	151	151
65	119	125	129	134	138	142	143	143	144	144
64	114	119	123	128	132	135	137	137	137	137
63	109	114	118	122	126	129	131	131	131	131
62	103	108	112	117	120	123	125	124	124	124
61	99	103	107	111	114	117	119	119	119	119

Figure 3.1.--One example of the 88 different graphs and data presented in Atlas of Men. (From Sheldon et al., 1954.)

Since the data that were generated by Sheldon et al. (94) were cross-sectional and the data for this study were longitudinal, the issue of height decrement had to be considered. As indicated in Chapter II, the decrease in height is negligible before the age of 60. Because the data from this study that were used to determine somatotype were from the age of 65 or earlier, the height decrement was not considered a problem. Therefore, direct comparisons were made.

The basis of decision making for the determination of somatotype used the absolute values of ponderal index at specific ages, the slope of the curve, the location of the peak of the curve, and the location and degree of the increase in ponderal index at the later ages if it existed. Unfortunately, the longitudinal data necessary to validate this method of somatotype prediction are not available. However, subjectively the investigators felt that there was good agreement in their ratings. In retrospect, this aspect of the study would be improved if the level of agreement was quantified.

Description of the Statistical Analyses

The independent variable considered in this study was longevity. A major problem with longevity studies is that each subject can have a different beginning point (birth) and different ending point (death) in the investigation. Therefore, at any given time in the study the age of death is unknown for many of the subjects. To avoid losing the data from those who were not deceased at the time of this study, life tables were used to predict age at death. Therefore, life

table age was used as the estimate of longevity. The BMDP Statistical Software (18) was used to generate the life-table data.

The somatotype rating system that was used in most of the comparisons was on a scale of 1 to 7 in each of the three components: endomorphy, mesomorphy, and ectomorphy. When it was necessary to use graphs, the 88 different somatotypes were placed into one of four groups based on Sheldon's original book, The Varieties of Human Physique (93). The four groups were endomorph, mesomorph, ectomorph, and balanced. The other measures of body type, ponderal index, weight/height, weight/height squared, and weight/height cubed, were compared by their absolute values.

In the statistical analyses several different comparisons were made. To consider the somatotypes of athletes and nonathletes, t-tests were used to compare the differences in the degree of each of the three components between the two groups. When the effect of somatotype and athleticism on longevity was considered, the Cox proportional hazards regression method was used. This was chosen because survival analysis was used. To further consider this issue, analysis of variance was used to compare longevity and the four somatotype groups. Subsequent testing for significance in the ANOVA was pairwise multiple comparisons with the Scheffe method. T-tests were used to test the correlations of the various quantitative body-type measures with longevity, and a chi-square was used to analyze the cross-tabulation of somatotype group with coronary artery disease and cancer. An alpha level of 0.05 was required to obtain statistical significance in all comparisons.

CHAPTER IV

RESULTS AND DISCUSSION

The purpose of this study was to evaluate the effect of different measures of body type of longevity and morbidity. Somatotype and other quantitative variables were evaluated. The primary consideration was the role of somatotype in athlete/nonathlete longevity studies of this type. Also, the relationship between the different somatotype groups and specific causes of death, such as coronary artery disease and cancer, were examined.

Somatotype and Athlete/Nonathlete Comparison

Two-sample t-tests (96) were used to compare the degree of somatotype in each of the three components between athletes and nonathletes. Three hundred ninety-eight athletes were compared with 369 nonathletes. Figure 4.1 illustrates the differences in somatotype between the two groups. As noted, the athletes were significantly ($p < .05$) more mesomorphic and less ectomorphic than the nonathletes. No significant differences were found between the two groups in the endomorphic component; however, the athletes were slightly less endomorphic. The results showing that athletes were more mesomorphic was expected since this was also found in two other studies (9, 74). However, the finding that athletes were less ectomorphic has not been

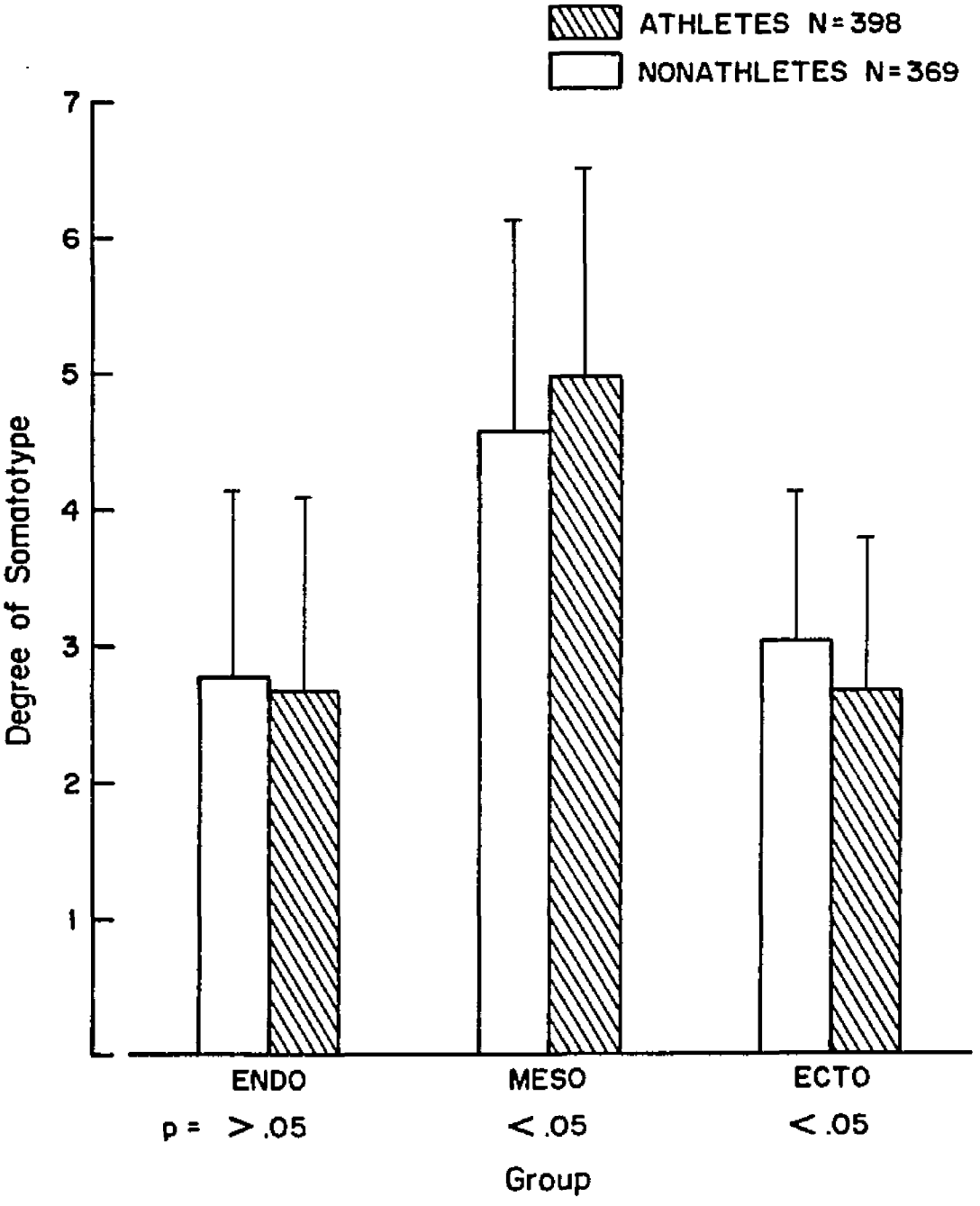


Figure 4.1.--Degree of the three somatotype components of athletes and nonathletes.

previously shown. Because many of the athlete subjects for this study were football players, the ectomorphic component may have been diluted. Since athletes and nonathletes do not have similar somatotypes, when making longevity comparisons between these two groups somatotype should be considered.

The Relationship of Somatotype and Athleticism to Longevity

When comparing both somatotype and athlete/nonathlete status with longevity, the Cox proportional hazards regression method (13, 18) was used. The global chi-square (13, 18) of this analysis indicated that together these variables were good predictors of life table age ($p = .001$). The effects of athlete/nonathlete status were tested by eliminating that variable from the possible predictors. The chi-square test (96) using a Wald statistic (18) was not significant ($p = .2853$). Therefore, somatotype alone is a significant contributor for predicting longevity irrespective of athletic status. When athletic status alone was tested using a global chi-square (13, 18), no significance ($p = .1894$) was found. This further supports the finding that somatotype is a good predictor of longevity and athlete/nonathlete status is not.

Life tables were used because subjects entered the study at different times, and the subjects were differentially lost from the study. However, since these subjects were matched in the beginning, the losses may not be differential. Therefore, multiple regression was used to describe these data. The results of this analysis indicated significant, positive relationships between life table age and

mesomorphy (p = .0210) and life table age and ectomorphy (p = .0067). However, endomorphy was not indicated as a significant contributor (p = .8499). Other analyses showed that the endomorphic component correlated most closely with longevity. This is contradictory to the multiple regression findings. Subsequent analysis indicated a high degree of intercollinearity between endomorphy and mesomorphy (Table 4.1), which helps explain these differences. Because of the intercollinearity, stepwise multiple regression cannot be trusted. Further evaluation shows that the nonexistence of certain somatotype groups which would be mathematically possible results in a built-in negative correlation (Tables 4.2, 4.3, and 4.4). However, when all three somatotype variables are entered into the Cox model, somatotype is a significant indicator of longevity, and it accounts for approximately 2% of the variability.

Table 4.1.--Somatotype correlation matrix.

	Endomorph	Mesomorph	Ectomorph
Endomorph	1.0000		
Mesomorph	-.8263	1.0000	
Ectomorph	.3165	-.6322	1.0000

In summary, the Cox proportional hazards regression method indicated that athlete/nonathlete status was not significantly correlated with longevity. On the other hand, somatotype was significantly correlated with longevity. Therefore, in athlete/nonathlete longevity studies, somatotype should be considered as a significant variable.

Table 4.2.--Two-way cross-tabulation of the degree of endomorphy and mesomorphy.

		Endomorphy						
		1	2	3	4	5	6	7
Mesomorphy	1	0	0	0	1	4	2	0
	2	0	0	0	18	47	1	2
	3	1	4	6	58	18	2	0
	4	7	23	67	56	6	0	0
	5	22	41	62	44	1	0	X
	6	82	55	12	1	0	X	X
	7	110	13	1	0	X	X	X

Note: X denotes no such somatotype.

Table 4.3.--Two-way cross-tabulation of the degree of endomorphy and ectomorphy.

		Endomorphy						
		1	2	3	4	5	6	7
Ectomorphy	1	50	24	3	6	1	3	1
	2	113	44	28	35	18	0	1
	3	29	31	51	57	36	2	X
	4	22	26	54	55	21	X	X
	5	7	11	12	25	0	X	X
	6	1	0	0	X	X	X	X
	7	0	0	X	X	X	X	X

Note: X denotes no such somatotype.

Table 4.4.--Two-way cross-tabulation of the degree of mesomorphy and ectomorphy.

		Mesomorphy						
		1	2	3	4	5	6	7
Ectomorphy	1	0	2	2	1	6	23	54
	2	0	13	4	15	50	87	70
	3	2	26	24	47	67	40	X
	4	4	16	40	71	47	X	X
	5	1	11	18	25	X	X	X
	6	0	0	1	X	X	X	X
	7	0	0	X	X	X	X	X

Note: X denotes no such somatotype.

Somatotype and Longevity Comparisons

The athlete/nonathlete data were pooled, and the four somatotype groups were compared with longevity (Figure 4.2). An analysis of variance (96) indicated a significant difference ($p = .001$) among the four somatotype groups of the pooled data. A pairwise multiple comparison post-hoc of the four groups with the Scheffe method (96) showed that the endomorphs differed ($p < .05$) from the three other groups. The average length of life for endomorphs was less. This is consistent with a similar investigation by Damon (15), who studied previous Harvard University students. The other comparisons were not significant.

The athlete-group data, when analyzed alone, exhibited similar results to the pooled-data results (Figure 4.3). The analysis of variance was significant ($p = .0012$). The Scheffe post-hoc (96) also

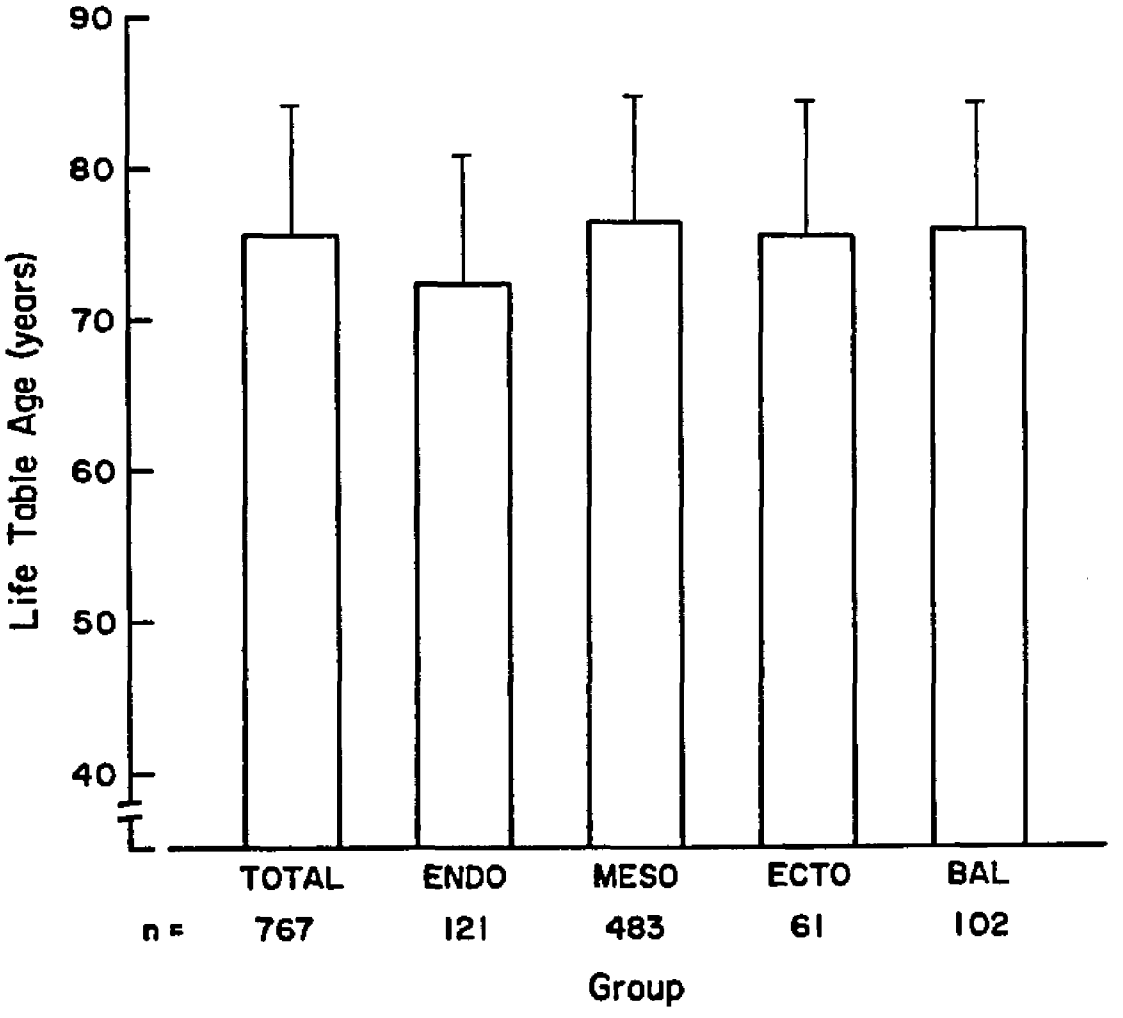


Figure 4.2.--Average age at death of the four somatotype groups with all subjects.

showed that the endomorphic group had a shorter average life than the other three groups ($p < .05$). When considering the other three groups, the ectomorphs were the longest lived. The balanced group was second longest, and the mesomorphs were third. These three groups were very close in mean age at death and were not statistically significant.

When nonathletes were considered alone, slight differences in longevity were found among the somatotype groups (Figure 4.4). An analysis of variance (96) using nonathlete data only was also significant ($p = .0308$). When pairwise multiple comparisons were made with the Scheffe method (96), only the mesomorphic and endomorphic groups varied significantly ($p < .05$). The mesomorphs lived significantly longer than the endomorphs. The balanced group had the next highest mean age at death, followed by the ectomorphs, but the differences were not statistically significant.

In conclusion, when considering athletes, the endomorphic group had a shorter average life span than the ectomorphic, mesomorphic, or balanced groups. When considering nonathletes, the only statistically significant difference in average length of life was between the shorter-lived endomorphic group and the mesomorphic group.

Height and Weight Measures and Longevity Comparisons

Several measures of body type using height and weight during college were used to make comparisons with longevity. The values considered were wt/ht, wt/ht^2, wt/ht^3, and ponderal index. Multiple correlations (96) were run to compare these four variables with life

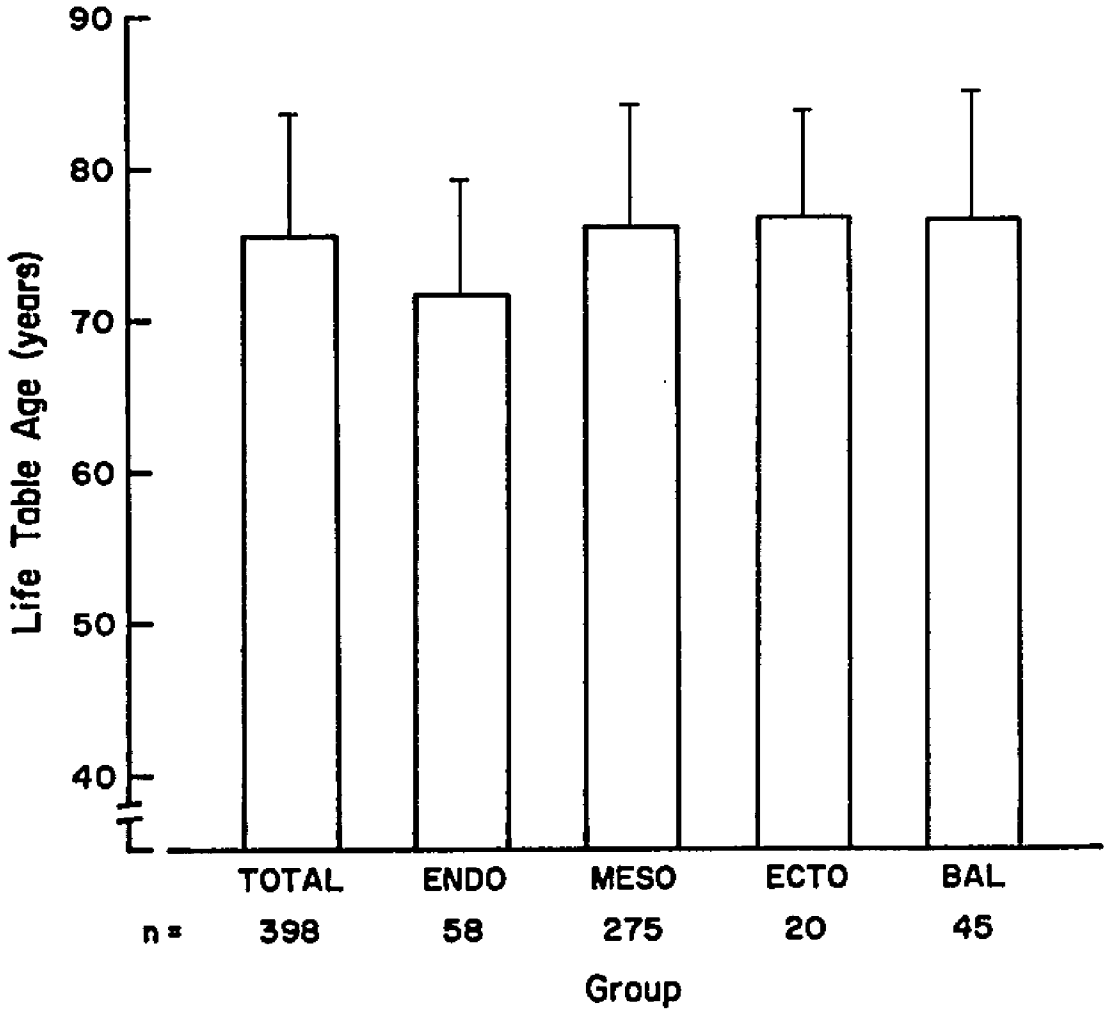


Figure 4.3.--Average age at death of the four somatotype groups with athletes.

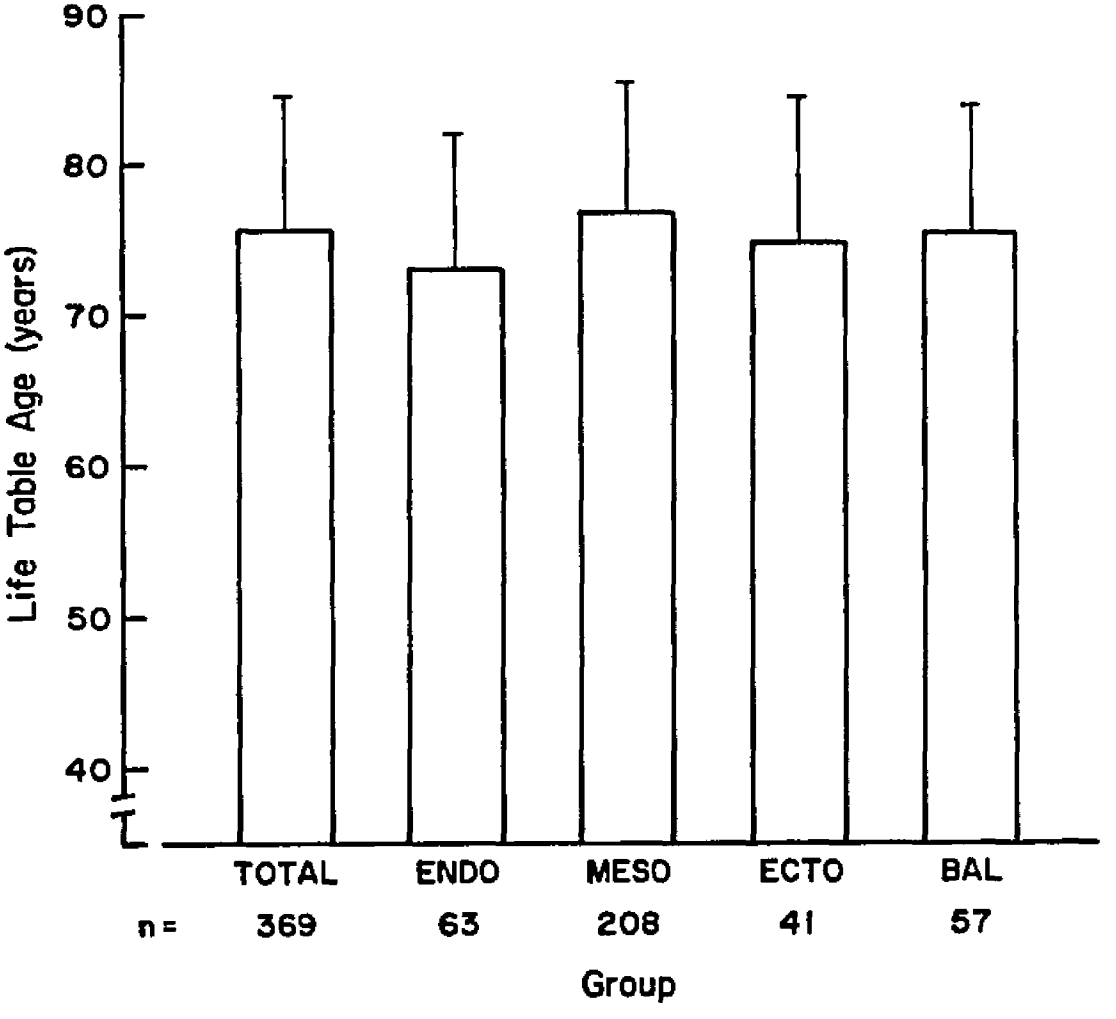


Figure 4.4.--Average age at death of the four somatotype groups with nonathletes.

table age using a t-test for analysis. When the total group of subjects was considered, wt/ht correlated the best with age at death, followed by wt/ht^2, wt/ht^3, and ponderal index. Only wt/ht was found to be a significant predictor ($p = .0105$). These results are listed in Table 4.5. Therefore, the best predictor of longevity among these variables is ht/wt. This is an inverse relationship and in general, when weight increases, the ht/wt decreases and expected longevity increases.

Table 4.5.--Correlations of height/weight variables with life table age of the 738 subjects.

	Correlation	Significance
wt/ht	-.0947	.0105
wt/ht^2	-.0549	.1384
wt/ht^3	-.0089	.8105
ponderal index	.0055	.8816

When only the athlete group was considered, wt/ht was also found as the only significant correlate ($p = .0075$). This was also a negative correlation at -0.1363. The other results are listed in Table 4.6, which shows wt/ht^2 as the second best predictor, ponderal index as third best, and wt/ht^3 as the worst. Therefore, the athletes resemble the total group when considering ht/wt.

The nonathlete group did not show similar results to the athlete and total groups. There were no significant relationships between nonathletes and any of the four variables. These results are

listed in Table 4.7. Despite the fact that none was significant, wt/ht was the best predictor, followed by ponderal index, wt/ht^3, and wt/ht^2.

Table 4.6.--Correlations of height/weight variables with life table age of the 384 athletes.

	Correlation	Significance
wt/ht	-.1363	.0075
wt/ht^2	-.0916	.0730
wt/ht^3	-.0331	.5178
ponderal index	.0370	.4692

Table 4.7.--Correlations of height/weight variables with life table age of the 354 nonathletes.

	Correlation	Significance
wt/ht	-.0558	.2955
wt/ht^2	-.0088	.8690
wt/ht^3	.0333	.5324
ponderal index	-.0419	.4320

Using quantitative variables of height and weight at college as predictors of longevity must be done with caution. The results of this analysis are not consistent with the literature. It is likely that none of these variables are good predictors. No significant differences were found when studying nonathletes. When considering athletes, only the wt/ht was significant and the correlation was only .1363. Therefore, these variables would not be considered good predictors of longevity in general.

Somatotype and Coronary Artery Disease Comparisons

The four somatotype groups were used to compare with the primary causes of death. To analyze the coronary artery disease (CAD) data, a comparison was made between the subjects who had died of CAD and the subjects who had died of other causes in each of the somatotype groups. The results are illustrated in Figure 4.5. All the somatotype groups had approximately 50% of the deaths due to CAD except the ectomorphs. Since only five ectomorphs had a known cause of death, there were too few subjects to draw any good conclusions. A chi-square test (96) was used to analyze these comparisons. No significant difference ($p = .6779$) was found. Therefore, no single somatotype group was determined as being more prone to CAD than other groups. A limiting factor in this comparison could be the low number of subjects (134) who had a known cause of death.

Somatotype and Cancer Comparisons

Cancer was also compared with other causes of death in each of the four somatotype groups. Figure 4.6 illustrates these results. Using a chi-square test (96) to analyze the differences in these four groups, no significance ($p = .7194$) was found. Cancer was therefore not significantly more prevalent as a cause of death in any one of the somatotype groups. Although it is not significant, the data indicate that the endomorphs are more likely to die of cancer. The low number of subjects (134) in this comparison was a limitation as well.

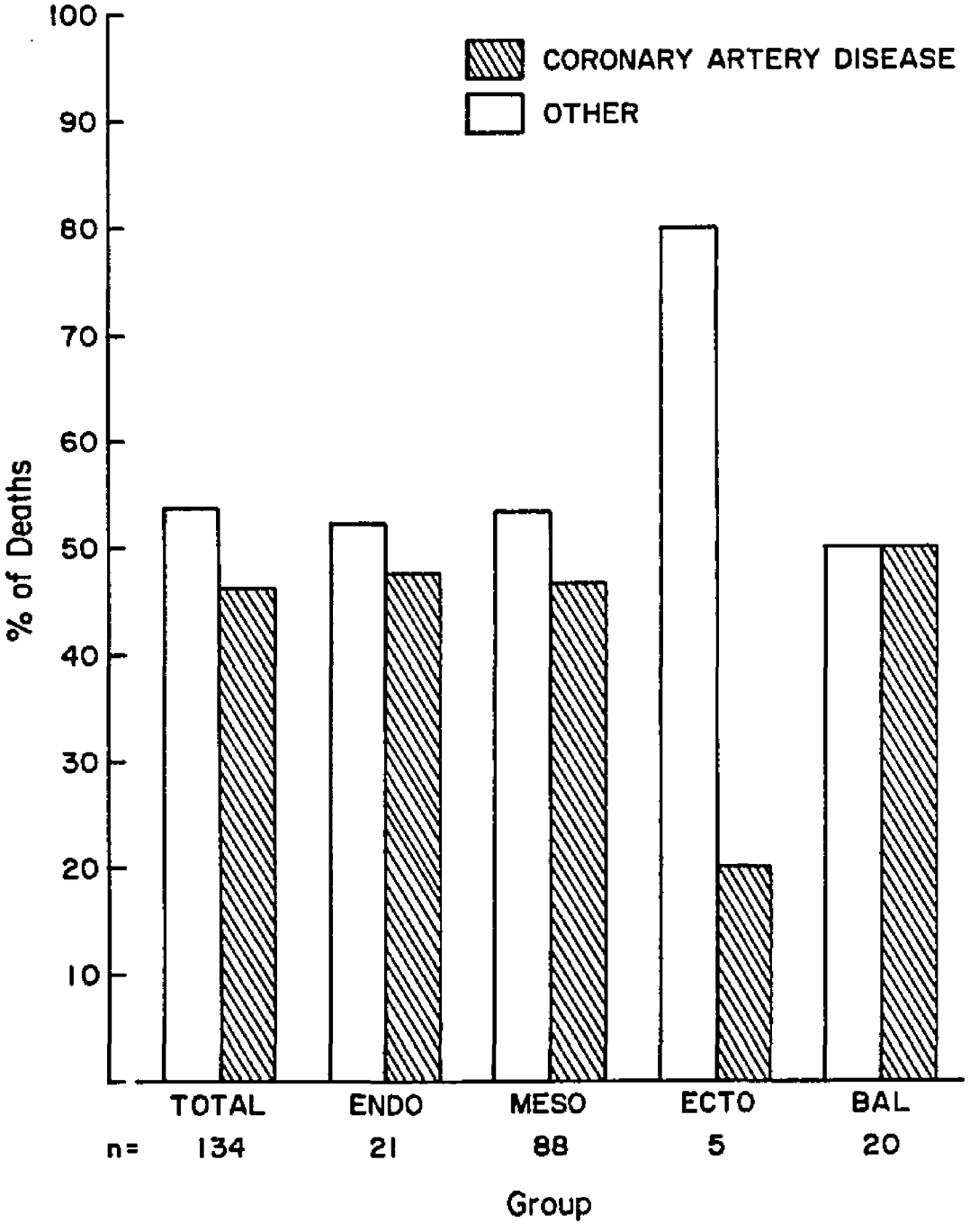


Figure 4.5.--Percentage of deaths from coronary artery disease of the four somatotype groups.

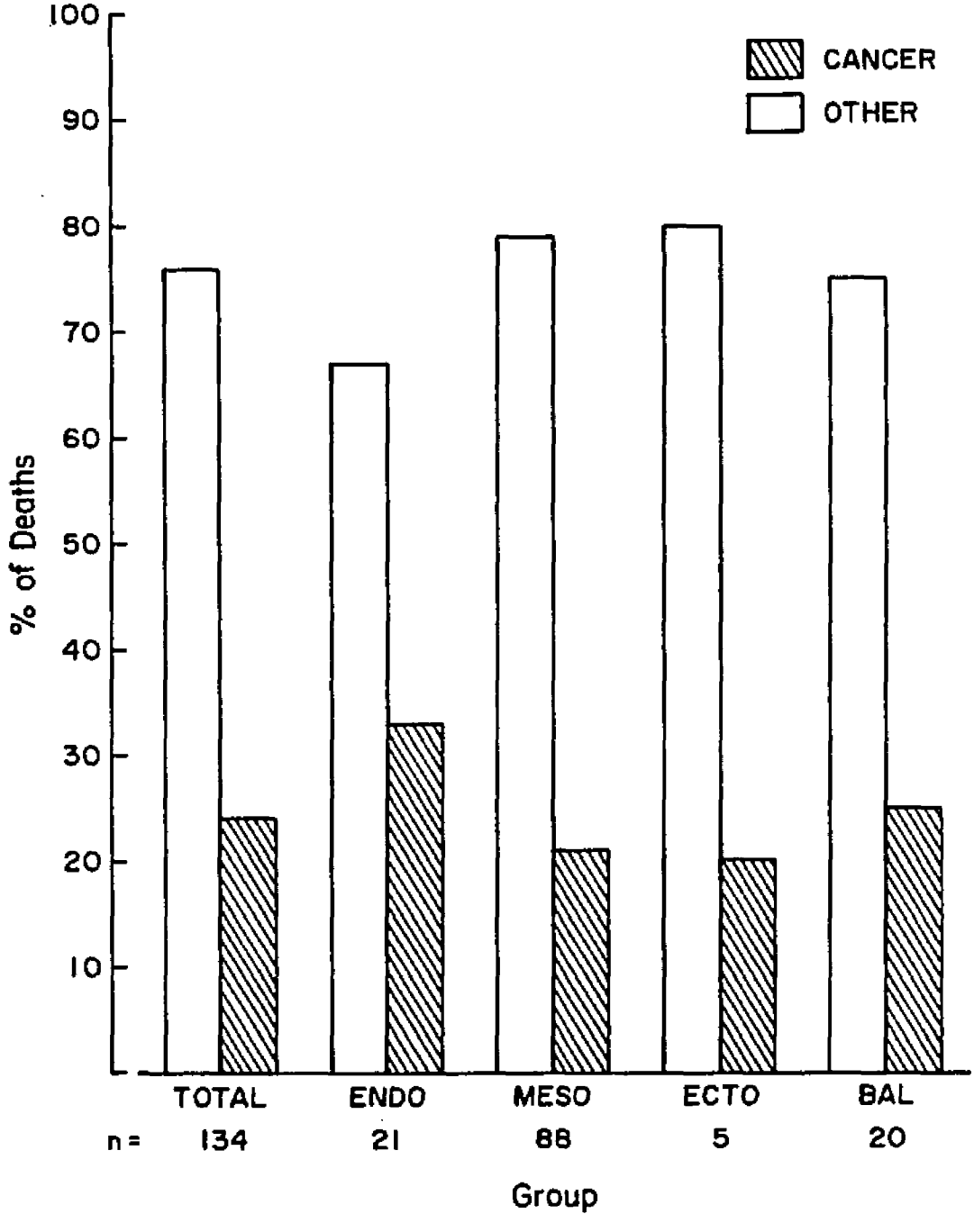


Figure 4.6.--Percentage of deaths from cancer of the four somatotype groups.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to evaluate the effect of different measures of body build on mortality and morbidity. Somatotype, wt/ht, wt/ht^2, wt/ht^3, and ponderal index were considered.

Seven hundred sixty-seven subjects who had attended Michigan State University before 1938 were used for this study. This group consisted of 398 athletes and 369 nonathletes. A somatotype was predicted for each subject, and the four height/weight measures were calculated using height and weight while in college.

The analyses indicated that athletes were more mesomorphic and less ectomorphic than nonathletes. When longevity was considered, athleticism was not a good predictor. Somatotype, however, was a statistically significant predictor. The endomorphic group was shorter lived than the other three groups.

When the quantitative variables were compared, only wt/ht was a statistically significant predictor of longevity. When nonathletes were considered, none of the height/weight variables was significant. Only in the athlete group was ht/wt a statistically significant predictor of longevity.

The relationship of somatotype and coronary artery disease (CAD) and cancer was also examined. No significant relationships were found in these limited data linking a specific somatotype group to CAD or cancer.

Conclusions

1. Athletes were more mesomorphic and less ectomorphic than nonathletes.

2. Somatotype is a good predictor of longevity, when compared with athleticism. Therefore, somatotype should be considered in athlete/nonathlete longevity studies.

3. In general, endomorphs live significantly shorter lives. In athletes the endomorphs differ significantly from mesomorphs, ectomorphs, and balanced individuals. Only the endomorphs and mesomorphs differ in the nonathlete group.

4. The best height/weight predictor of longevity is wt/ht. This is significant in the athlete group but nonsignificant in the nonathlete group.

5. There is no significant difference among the four somatotype groups and the likelihood of dying from CAD or cancer.

Recommendations

1. Similar studies should determine somatotype at the beginning of the investigation.

2. Follow-up studies should be considered until all the subjects are deceased.

3. Similar studies should be conducted on female athletes and nonathletes.

APPENDICES

APPENDIX A

BREAKDOWN OF ATHLETE SUBJECTS BY SPORT

Breakdown of Athlete Subjects by Sport

Sport	N
Football	121
Basketball	12
Track/cross country	134
Baseball	59
Other	72
Total	398

APPENDIX B

QUESTIONNAIRES

(1952, 1960, 1968, 1976, 1984)

NATIONAL STUDY OF LONGEVITY AND MORBIDITY OF ATHLETES IN COLLEGES AND UNIVERSITIES

Form A. This Form is for graduates who earned a college letter in one or more sports
(Please Fill in this Form as Completely and Accurately as Possible)

Date _____

Name of Athlete (please print)	Year of Birth	Weight at Graduation from College

IF ATHLETE IS LIVING

Present address _____

Present weight _____ lbs.

Present general condition of health
(Check one):
Good _____
Fair _____
Poor _____

Married _____ Single _____
(Check one)

IF ATHLETE IS DECEASED

Age at death _____ yrs.

Cause of death stated on death certificate:
Primary _____
Secondary _____

If answer is unknown, state the generally accepted cause of death _____

Was death sudden _____ or lingering _____

Was he married _____ or single _____

Person entering information on this form:
Name _____
Address _____
Relationship _____

Athletic and General Sports History of Athlete

Name of Sport	High School	College	Amateur Non-School	Professional	Age
					yrs. to yrs. of age
					yrs. to yrs. of age
					yrs. to yrs. of age
					yrs. to yrs. of age
					yrs. to yrs. of age
					yrs. to yrs. of age

Activity During Adult Life, *Excluding* Playing Participation In Sports

Include vocational and avocational activities
Number of hours of physical activity (daily or almost daily)

Age	Vigorous	Moderate	Mild
yrs. to yrs.	hrs.	hrs.	hrs.
yrs. to yrs.	hrs.	hrs.	hrs.
yrs. to yrs.	hrs.	hrs.	hrs.
yrs. to yrs.	hrs.	hrs.	hrs.

Military Service

Branch of Service _____ Age _____ yrs. to _____ yrs.
Physical activity involved (check): Vigorous _____ Moderate _____ Mild _____
If more than one branch of the Service, name the others and indicate the amount of physical activity involved _____

Economic Status of Home From Early Childhood Upward

Before and During College years	After College Years	Comments
(check one)	(check one)	
Satisfactory _____	Satisfactory _____	
Unsatisfactory _____	Unsatisfactory _____	

(OVER)

Medical History

AILMENT

1. Infectious and Contagious Diseases (State age of occurrence). _____

2. Childhood rheumatism (State, if possible, age of occurrence of any manifestations in this group). Growing pains ____ Chorea ____ Rheumatic fever _____ 1st attack _____ 2nd attack _____ 3rd attack _____ Tonsilitis____ Tonsils removed____ Heart defects (give as complete a diagnosis as possible, such as murmurs, enlargement, irregularity, heart failure, etc). _____

3. Hypertension (Mention complications such as strokes, coronary thrombosis, heart failure, uremia, etc., along with age of occurrence) _____

4. Arteriosclerosis _____

5. Angina Pectoris _____ Coronary Thrombosis _____ *Indicate frequency of attacks*

Diabetes _____ Peripheral Vascular Disease _____

6. Other Diseases (mention organ or body system affected, and age of occurrence): _____

Smoking and Drinking Habits

Use alcoholic drinks: never _____ moderately _____ excessively _____

Use tobacco: What form _____ How much _____

Hereditary History

Relationship	If Living		If Deceased	
	Age	Ailment, if any	Age at Death	Cause of Death
Paternal grandfather				
Paternal grandmother				
Maternal grandfather				
Maternal grandmother				
Father				
Mother				
Brothers				
Sisters				

(If Hypertension, Coronary Thrombosis or Diabetes present in family, please indicate)

Do you think that participation in athletics is beneficial, harmful, or has no effect?

Please comment, if critical of program, give reasons _____

Other comments which will provide additional information on your participation or lack of participation in sports.

Some examples: "Did not participate in college because I was no longer an amateur athlete." "Did not participate on advice of a physician." "Did not participate because I had to work my way through college." "I wasn't good enough to make the team." Etc _____

NATIONAL STUDY OF LONGEVITY AND MORBIDITY OF MALE GRADUATES OF COLLEGES AND UNIVERSITIES

Form B. This Form is for men who did not earn a letter in sports

(Please Fill in this Form as Completely and Accurately as Possible)

Date _____

Name of Alumnus (please print) _____ Year of Birth _____ Weight at Graduation from College _____

IF ALUMNUS IS LIVING

Present address _____

Present weight _____ lbs.

Present general condition of health

(Check one):

Good _____

Fair _____

Poor _____

Married _____ Single _____

(Check one)

IF ALUMNUS IS DECEASED

Age at death _____ yrs.

Cause of death stated on death certificate:

Primary _____

Secondary _____

If answer is unknown, state the generally accepted cause of death _____

Was death sudden _____ or lingering _____

Was he married _____ or single _____

Person entering information on this form:

Name _____

Address _____

Relationship _____

Athletic and General Sports History of Alumnus

Name of Sport	High School	College	Amateur Non-School	Professional	Age
					yrs. to yrs. of age
					yrs. to yrs. of age
					yrs. to yrs. of age
					yrs. to yrs. of age
					yrs. to yrs. of age
					yrs. to yrs. of age

Activity During Adult Life, *Excluding* Playing Participation In Sports

Include vocational and avocational activities

Age	Number of hours of physical activity (daily or almost daily) Vigorous	Moderate	Mild
yrs. to yrs.	hrs.	hrs.	hrs.
yrs. to yrs.	hrs.	hrs.	hrs.
yrs. to yrs.	hrs.	hrs.	hrs.
yrs. to yrs.	hrs.	hrs.	hrs.

Military Service

Branch of Service _____ Age _____ yrs. to _____ yrs.

Physical activity involved (check): Vigorous _____ Moderate _____ Mild _____

If more than one branch of the Service, name the others and indicate the amount of physical activity involved _____

Economic Status of Home From Early Childhood Upward

Before and During College years	After College Years	Comments
(check one)	(check one)	
Satisfactory _____	Satisfactory _____	
Unsatisfactory _____	Unsatisfactory _____	

(OVER)

Medical History

AILMENT

1. Infectious and Contagious Diseases (State age of occurrence).

2. Childhood rheumatism (State, if possible, age of occurrence of any manifestations in this group).

Growing pains ____ Chorea ____
Rheumatic fever _____
1st attack _____
2nd attack _____
3rd attack _____
Tonsilitis ____ Tonsils removed____
Heart defects (give as complete a diagnosis as possible, such as murmurs, enlargement, irregularity, heart failure, etc). _____

3. Hypertension (Mention complications such as strokes, coronary thrombosis, heart failure, uremia, etc., along with age of occurrence) _____

4. Arteric Sclerosis _____

5. Angina Pectoris _____ Coronary Thrombosis _____
Indicate frequency of attacks
Diabetes _____ Peripheral Vascular Disease _____

6. Other Diseases (mention organ or body system affected, and age of occurrence): _____

Smoking and Drinking Habits

Use alcoholic drinks: never _____ moderately _____ excessively _____
Use tobacco: What form ____ _____ How much _____

Hereditary History

Relationship	If Living		If Deceased	
	Age	Ailment, if any	Age at Death	Cause of Death
Paternal grandfather				
Paternal grandmother				
Maternal grandfather				
Maternal grandmother				
Father				
Mother				
Brothers				
Sisters				

(If Hypertension, Coronary Thrombosis or Diabetes present in family, please indicate)

Do you think that participation in athletics is beneficial, harmful, or has no effect?

Please comment; if critical of program, give reasons _____

Other comments which will provide additional information on your participation or lack of participation in sports.

Some examples "I played basketball for high school during afternoons and for a club in the evenings in 1938." "Did not play football during junior college year on account of fracture or operation." "Etc _____"

MICHIGAN STATE UNIVERSITY
Department of Health, Physical Education and Recreation

FOLLOW-UP STUDY OF LONGEVITY AND MORBIDITY OF
MALE GRADUATES OF MICHIGAN STATE UNIVERSITY

NAME OF ALUMNUS (Please print) _____Date_____

PRESENT ADDRESS _____

MARITAL STATUS (Check one) __Married __Single __Widowed __Divorced

PRESENT WEIGHT _____lbs. If your weight has changed more than 15 lbs. within the last seven years, please explain _____

RACE __White __Negro __Other _____

PRESENT OCCUPATION _____From 19__ to 19__

ANY PREVIOUS FULL TIME OCCUPATIONS:

1. _____From 19__ to 19__
2. _____From 19__ to 19__
3. _____From 19__ to 19__
4. _____From 19__ to 19__

SMOKING HABITS:
(Please check only those which apply)

__Smoke __Do not smoke
(If you do not smoke, please disregard the remaining questions in this section)

Cigarettes:
1. Less than 1/2 pack per day__
2. 1/2 to 1 pack per day__
3. Over 1 pack per day__

Cigars:
1. Less than 3 per day__
2. 3 to 6 per day__
3. Over 6 per day__

Pipe:
1. Less than 4 bowls per day__
2. 4 to 10 bowls per day__
3. Over 10 bowls per day__

Chew:
1. Less than 1/4 pack per day__
2. 1/4 to 3/4 pack per day__
3. Over 3/4 pack per day__

DRINKING HABITS
(Please check only those which apply)

__Drink __Do not drink
(If you do not drink, please disregard the remaining questions in this section)

Beer:
1. Occasional bottle__
2. 1 to 3 bottles per day__
3. Over 3 bottles per day__

Wine:
1. Occasional glass other than for religious use__
2. Daily but less than 1/2 bottle__
3. Over 1/2 bottle per day__

Whiskey (gin, etc.):
1. Occasional glass__
2. 1 to 3 shots per day__
3. 4 to 6 shots per day__
4. Over 6 shots per day__

LONGEVITY OF BROTHERS AND SISTERS: (If any of your brothers and sisters have died in the past seven years, please furnish information requested)

Relationship	Cause of Death	Age at Death
Brothers		
Sisters		

MEDICAL HISTORY: What ailments have you had in the last seven years? (Examples: Coronary Thrombosis, High Blood Pressure, Cancer, Diabetes, TB, etc.)

		Age at Occurrence
1.		
2.		
3.		
4.		

FAMILY: Do you have any children? __Yes __No
(If your answer is yes, please furnish information requested)

Sons: Number living___ Number deceased___
Age and cause of death _____

Daughters: Number living___ Number deceased___
Age and cause of death _____

NON-VOCATIONAL ACTIVITY RECORD FOR THE PAST YEAR:

1. Do you __Mow your own lawn? __Do other yard or house maintenance?
(Please describe)_____

2. Do you __Have a garden? What do you do in connection with this?
_____

3. Do you __Do any sitting up exercises in the winter?
__In the summer? How long does each session last? _____
When was the last time?_____ The time before that?
_____

4. Do you walk or bike to work? _____ How far? _____
How often? _____

5. Do you have any hobbies or engage in other non-vocational work or recreation regularly? EXCLUDING SPORTS (Please list below)

Hobby or Activity	How Often Do You Participate?
a.	
b.	
c.	
d.	

6. What sports did you engage in regularly during the past summer months? (Please use the list below as a guide)

	Sport	How Often?	When Was the Last Time?	The Time Before?
a.				
b.				
c.				
d.				
e.				

7. What sports did you engage in regularly during the past winter months? (Please use the list below as a guide)

	Sport	How Often?	When Was the Last Time?	The Time Before?
a.				
b.				
c.				
d.				
e.				
f.				

LIST OF SPORTS ACTIVITIES

Angling (fishing)
Archery
Badminton
Baseball
Basketball
Bicycling
Birling
Bob-Sledding
Bowling
Boxing
Canoeing
Codeball
Cricket
Cross Country
Curling
Fencing
Field Ball
Football
Golf
Gymnastics
Handball
Hiking
Hockey (field)
Hockey (ice)
Horseback Riding
Horseshoe Pitching
Hunting
Hurling
Ice Boating
Jai Alai
JuJitsu
Lawn Bowling
Mountain Climbing
Paddle Tennis
Polo (horse)
Polo (water)
Rowing and Sculling
Sailing
Shuffleboard
Skating (ice)
Skating (roller)
Skeet and/or Trap Shooting
Skiing
Snow Shoeing
Squash Rackets
Swimming
Table Tennis
Tennis
Track and Field
Trapping
Volley Ball
Walking Competitive
Weight Lifting
Wrestling

Serial No. _____

SECOND FOLLOW-UP OF THE LONGEVITY
AND MORBIDITY OF MALE GRADUATES OF MICHIGAN STATE UNIVERSITY

Name of Alumnus _____ Date _____

Street _____ City _____ State _____

PERSONAL INFORMATION

1. Have there been any changes in your marital status since 1960 (our previous follow up)?
   Yes ☐ No ☐
   (If yes to question 1, answer A; if no, move on to question 2)

   A. Please Explain _____

2. Present weight _____ lbs. A. Have you lost 15 lbs. or more since 1960? Yes ☐ No ☐
   (If yes to question A, answer 1 and 2; if no, move on to question 3)

   1. How many times did you lose this much weight? 1-2 times ☐ 3 or more times ☐
   2. Any specific reason for these weight fluctuations? _____

3. Height (in inches) _____
4. Which of these body type classification do you feel is closest to your body build?
   Stocky ☐ Medium ☐ Slender ☐

OCCUPATIONAL INFORMATION

5. Are you presently working (job or self employed)? Yes ☐ No ☐
   (If no, answer A; if yes, move on to question 6)

   A. Have you had a job or been self employed at any time since 1960? Yes ☐ No ☐
   (If no, skip to question 7; if yes, move on to question 6)

6. Answer the following questions about your present occupation or the last job you have had since 1960.
   A. What kind of work (for example, engineer, teacher, doctor) _____
   B. About how much time on the job is spent sitting?
      Practically all ☐ More than half ☐ About half ☐ Almost none ☐
   C. About how much time on the job is spent walking?
      Practically all ☐ More than half ☐ About half ☐ Almost none ☐
   D. About how much walking getting to and from your job? Blocks _____ Miles _____
   E. What type of transportation do you use to and from your job (check all that apply)
      Subway ☐ Bus ☐ Car ☐ Bicycle ☐ Others (Please describe) _____
   F. How often do you have to lift heavy weights or carry heavy things on the job?
      Frequently ☐ Sometimes ☐ Very infrequently (or never) ☐
   G. How many hours a week do you work on your job? _____ (Hours per week)
   H. How much tension in your job? Great Deal ☐ Some ☐ Very Little ☐ None ☐
   I. Any responsibility for supervising other workers on the job? Yes ☐ No ☐
      (If yes, answer 1; if no, move on to J)

      1. About how many on the average do you supervise? _____

   J. When did you start on this job? Year _____
   K. Just before this job were you doing the same type of work?
      Yes, did the same type of work ☐. I was on that job _____ years. No, this was my first job ☐.
      No, did different type of work ☐. If you check this item, please answer the following questions. 1, 2, 3, and 4:

      1. How long did you do this different type of work? _____ years.
      2. What kind of work was it? _____
      3. On this job did you spend more or less time sitting than your present job?
         More ☐ Less ☐ Same ☐
      4. Was there more or less walking on this earlier job than on your present (or last) job?
         More ☐ Less ☐ Same ☐

LEISURE TIME ACTIVITIES

7. How often do you do the following? (For each activity listed, please check whether you do it frequently, sometimes, or very infrequently.)

	Frequently	Sometimes	Very Infrequently (Or Never)
A. Take walk in good weather	☐	☐	☐
B. Work around the house or apartment (painting, repairing, etc.)	☐	☐	☐
C. Gardening in spring or summer	☐	☐	☐
D. Take part in sports during season	☐	☐	☐

E. If you take part in sports, please indicate what kind of sports and frequency either by the week or year.

SPORT	Frequency Per Wk. or Per Yr.	SPORT	Frequency Per Wk. or Per Yr.
☐ Angling (fishing)	____ ____	☐ Judo	____ ____
☐ Archery	____ ____	☐ Lawn Bowling	____ ____
☐ Badminton	____ ____	☐ Mountain Climbing	____ ____
☐ Baseball	____ ____	☐ Paddle Tennis	____ ____
☐ Basketball	____ ____	☐ Polo (horse)	____ ____
☐ Bicycling	____ ____	☐ Polo (water)	____ ____
☐ Bob-Sledding	____ ____	☐ Rowing & Sculling	____ ____
☐ Bowling (exclude lawn bowling here)	____ ____	☐ Shuffleboard	____ ____
☐ Boxing	____ ____	☐ Skating (ice)	____ ____
☐ Canoeing	____ ____	☐ Skating (roller)	____ ____
☐ Codeball	____ ____	☐ Skiing	____ ____
☐ Cricket	____ ____	☐ Snow Shoeing	____ ____
☐ Cross Country	____ ____	☐ Squash Rackets	____ ____
☐ Curling	____ ____	☐ Swimming	____ ____
☐ Fencing	____ ____	☐ Table Tennis	____ ____
☐ Football	____ ____	☐ Tennis	____ ____
☐ Golf	____ ____	☐ Track & Field	____ ____
☐ Gymnastics	____ ____	☐ Trapping	____ ____
☐ Handball	____ ____	☐ Volleyball	____ ____
☐ Hiking	____ ____	☐ Weight Lifting	____ ____
☐ Hockey (field)	____ ____	☐ Wrestling	____ ____
☐ Hockey (ice)	____ ____		
☐ Horseback Riding	____ ____	Others:	
☐ Horseshoe Pitching	____ ____	☐ _____	____ ____
☐ Hunting	____ ____	☐ _____	____ ____
☐ Ice Boating	____ ____	☐ _____	____ ____
☐ Jai Alai	____ ____	☐ _____	____ ____

F. Have you been using an exercise plan at any time during or since 1960? Yes ☐ No ☐
(If yes to question F, answer 1 and 2; if no, answer question G)

1. Please check how often you used this plan. Frequently ☐ Sometimes ☐ Very infrequently ☐
2. Give a brief explanation of the exercises and amounts of time spent. _____

G. Up till the time you graduated from high school did you live mostly on the farm? ☐ How many years? _____ Or did you live in the city? ☐ How many years? _____ .

DIET RECALL

8. List the things you ate and drank yesterday (this should preferably be a week day) When possible, give the specific name of the item, e.g., Fresca or Coca Cola, rather than soft drink; McDonald's hamburger, whole milk, skim milk, half and half, rather than just milk. Indicate the amount you ate or drank in terms of cups (200 ml), tablespoons, teaspoons, ounces, numbers and approximate size, e.g., small, large, medium for fruits, vegetables, etc.

You may list meats either in ounces or size of pieces: one hamburger patty (3" diameter x 1" thick) weighs 3 oz.; an average serving of steak (3" x 3" x ½") weighs 3 oz. Be sure to include everything you ate or drank yesterday — candy, liquor, coffee (list sugar and cream, if used), popcorn, potato chips, etc., as well as your regular meals. To help you estimate sizes, a rule is marked off on the edge of this page.

Breakfast	
Item	Amount or Size

Morning Snacks	
Item	Amount or Size

Lunch	
Item	Amount or Size

Afternoon Snacks	
Item	Amount or Size

Dinner	
Item	Amount or Size

Evening Snacks	
Item	Amount or Size

A. Check date of diet record. Sun. ☐ Mon. ☐ Tues. ☐ Wed. ☐ Thurs. ☐ Fri. ☐ Sat. ☐

B. Did yesterday's meals include any special or unusual event, e.g., party, birthday, anniversary, picnic, etc.? Yes ☐ No ☐

1. If yes, what was it?_____

C. Does the above represent your usual day's food intake? Yes ☐ No ☐

1. If no, how did it differ from your usual intake?_____

D. Check the column which indicates the approximate frequency with which you consume each food.

Food	Daily	Weekly	Never
Whole milk			
Cream or half and half			
Ice cream, not ice milk			
Cheese (other than cottage)			
Butter			
Margarine			
Sour cream			
Salad dressings (not low calorie)			
Eggs			
Gravy			
Fat around meat			
Pork			
Veal			
French-fried potatoes			
Fried meat, fried potatoes, etc.			
Other deep-fat fried foods			

Food	Daily	Weekly	Never
Fish			
Beef			
Cream or custard pies			
Cream pudding			
Sugar (in coffee, tea, etc			
Sugar on cereal			
Sugar on fruits, vegetables			
Frosted cakes, brownies, sweet rolls, etc			
Soft drinks (other than low or non-calorie)			
Honey			
Jelly, jam, preserves, marmalade			
Syrups (on pancakes, waffles, etc.)			
Molasses			
Sweetened fruit juices, syrups, etc			

9. Do you drink coffee? Yes ☐ No ☐ (If yes, answer question a; if no, go on to question 10)

A. What is the average number of cups per day? 1-3 ☐ 4-6 ☐ 7-9 ☐ more ☐ .

SMOKING HABITS

10. Do you smoke at the present time? Yes ☐ No ☐ (If yes to question 10, answer A and B)

A. About how old were you when you first began to smoke? _____ Yrs. old.

B. What is the average number of cigarettes_____ cigars_____ pipefuls_____ you smoke per day. (continue on to question 11)

(If no to question 10, answer C)

C. Did you ever smoke regularly? Yes ☐ No ☐

(If yes to C, answer 1, 2, and 3, if no, move on to question 11)

1. About how old were you when you started smoking? _____ Yrs. old.
2. About how old were you when you stopped smoking? _____ Yrs. old.
3. When you were smoking, what was the average number of cigarettes_____ cigars_____ pipefuls_____ that you smoked per day?

DRINKING HABITS

11. Do you drink at the present time? Yes ☐ No ☐

(If yes to question 11, answer A)

A. Please check the amounts you usually drink.

Beer	Wine	Whiskey (gin, etc.)
☐ Occasional bottle	☐ Occasional glass other than for religious use	☐ Occasional glass
☐ 1 to 3 bottles per day	☐ Daily, but less than ½ bottle	☐ 3 to 6 shots per day
☐ over 3 bottles per day	☐ Over ½ bottle per day	☐ over 6 shots per day

(continue on to question 12)

(If no to question 11, answer B)

B. Did you ever drink regularly? Yes ☐ No ☐

(If yes to question B, answer 1 and 2; if no, go on to question 12)

1. Please give the number of years that you drank regularly before you quit _____Yrs., and why you quit _____
2. Please check the amounts you usually drank.

Beer	Wine	Whiskey (gin, etc.)
☐ Occasional bottle	☐ Occasional glass other than for religious use	☐ Occasional glass
☐ 1 to 3 bottles per day	☐ Daily, but less than ½ bottle	☐ 3 to 6 shots per day
☐ over 3 bottles per day	☐ Over ½ bottle per day	☐ over 6 shots per day

HEREDITARY HISTORY

12. If there are any changes in this history since 1960, will you please bring this information up to date, and make any additions or corrections in the data listed below.

RELATIONSHIP	If Living		If Deceased	
	Age	Ailment, if any	Age at Death	Cause of Death
Father				
Mother				
Brothers				
Sisters				

A. Father's occupation _____

MEDICAL HISTORY

13. If you have had any of these diseases since 1960, will you please bring this information up to date. Make any correction or addition in the data we listed below.

Ailment	Age at Onset	Are you still troubled with this condition?		Are you taking medication or treatment for it?	
		Yes	No	Yes	No
High Blood Pressure	_____	☐	☐	☐	☐
Angina Pectoris	_____	☐	☐	☐	☐
Stroke (Cerebral Thrombosis)	_____	☐	☐	☐	☐
Heart Attack (Coronary Thrombosis)	_____	☐	☐	☐	☐
Rheumatic Heart Disease	_____	☐	☐	☐	☐
Cancer	_____	☐	☐	☐	☐
Diabetes	_____	☐	☐	☐	☐
Tuberculosis	_____	☐	☐	☐	☐
Ulcer	_____	☐	☐	☐	☐
Liver Ailment	_____	☐	☐	☐	☐
Arthritis	_____	☐	☐	☐	☐
Gout	_____	☐	☐	☐	☐
Other	_____	☐	☐	☐	☐

Serial No. _____

THIRD FOLLOW-UP OF THE LONGEVITY
AND MORBIDITY OF MALE GRADUATES OF MICHIGAN STATE UNIVERSITY

Name of Alumnus _____ Date _____

Street _____ City _____ State _____

Social Security Number _____

PERSONAL INFORMATION

1. Have there been any changes in your marital status since 1968 (our previous follow-up)?
Yes ☐ No ☐
(If yes to question 1, answer A; if no, move on to question 2)

A. Please Explain _____

2. Present weight ____ lbs. A. Have you lost 15 lbs. or more since 1968? Yes ☐ No ☐

OCCUPATIONAL INFORMATION

3. Are you presently working (job or self employed)? Yes ☐ No ☐
(If no, answer A; if yes, move on to question 4)

A. Have you had a job or been self employed at any time since 1968? Yes ☐ No ☐
(If no, skip to question 5; if yes, move on to question 4)

4. Is this the same job you reported on the 1968 questionnaire? Yes ☐ No ☐
(If yes, move on to question 5; if no, answer the following questions A through J.

A. What kind of work (for example, engineer, teacher, doctor) _____

B. About how much time on the job is spent sitting?
Practically all ☐ More than half ☐ About half ☐ Almost none ☐

C. About how much time on the job is spent walking?
Practically all ☐ More than half ☐ About half ☐ Almost none ☐

D. Do you ever walk to or from work? Yes ☐ No ☐
If yes, how far do you walk? Blocks ____ Miles ____ How many times a year _____
Do you ever bicycle to and from work? Yes ☐ No ☐ If yes, how far do you cycle (both ways)?
Blocks ____ Miles ____ Number of times per year _____

E. What type of transportation do you use to and from your job (check all that apply)?
Subway ☐ Bus ☐ Car ☐ Bicycle ☐ Walking ☐ Others (Please describe) _____

F. How often do you have to lift heavy weights or carry heavy things on the job?
Frequently ☐ Sometimes ☐ Very infrequently (or never) ☐

G. How many hours a week do you work on your job? ____ (Hours per week)

H. How much tension in your job? Great deal ☐ Some ☐ Very little ☐ None ☐

I. Any responsibility for supervising other workers on the job? Yes ☐ No ☐
(If yes, answer 1; if no, move on to J)

1. About how many on the average do you supervise? _____

J. When did you start on this job? Year _____

LEISURE TIME ACTIVITIES

5. How many hours a month do you do the following activities and which months? (List number of hours involved in each activity under the month(s) you participate. Leave blank where not involved.)

ACTIVITY	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Fishing - bank, boat, ice												
Fishing - wading												
Archery, target												
Badminton												
Baseball - hard, soft												
Basketball												
Bicycling - pleasure												
Tobagganing, sledding												
Bowling, including lawn												
Canoeing or rowing												
Jogging												
Curling												
Fencing												
Gardening												
Lawn mowing - riding												
Lawn mowing - power mower												
Lawn mowing - hand mower												
Snow shoveling												
Golf - walking												
Golf - power cart												
Handball, including paddleball, racket and squash												
Walking - back packing												
Walking - cross country												
Walking - mountain climbing												
Walking - pleasure												
Home workshop (carpentry)												
Horseback riding												
Horseshoe pitching												
Hunting - bow and gun												
Sailing - ice and water												
Judo, including karate												
Paddle tennis												
Rowing, skulling												
Shuffleboard (not hand)												
Skating - ice, roller												
Skiing - downhill												
Skiing - cross country												
Skiing - water												
Snowshoeing												
Dancing - ballroom												
Dancing - square												
Swimming - pleasure												
Swimming - exercise												
Table tennis												
Tennis - singles												
Tennis - doubles												
Volleyball												
Weight lifting												
Calisthenics - home												
Calisthenics - Health Club												
Others:												
_____												
_____												
_____												
_____												
_____												
_____												
_____												
_____												
_____												

6. If you have been routinely exercising under a home exercise plan or Health Club plan (commercial, Y.M.C.A., Athletic Club, etc.) answer the following questions:

A. Number of hours per month _____, which months (circle): Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.

B. What type of exercises? _____

DIET RECALL

7. List the things you ate and drank yesterday (this should preferably be a week day). When possible, give the specific name of the item, e.g., Fresca or Coca Cola, rather than soft drink; McDonald's hamburger, whole milk, skim milk, half and half, rather than just milk. Indicate the amount you ate or drank in terms of cups (200 ml), tablespoons, teaspoons, ounces, numbers and approximate size, e.g., small, large, medium for fruits, vegetables, etc.

You may list meats either in ounces or size of pieces: one hamburger patty (3" diameter x 1" thick) weighs 3 oz.; an average serving of steak (3" x 3" x ½") weighs 3 oz. Be sure to include everything you ate or drank yesterday — candy, liquor, coffee (list sugar and cream, if used), popcorn, potato chips, etc., as well as your regular meals. To help you estimate sizes, a rule is marked off on the edge of this page.

Breakfast		Morning Snacks	
Item	Amount or Size	Item	Amount or Size

Lunch		Afternoon Snacks	
Item	Amount or Size	Item	Amount or Size

Dinner		Evening Snacks	
Item	Amount or Size	Item	Amount or Size

A. Check date of diet record: Sun. ☐ Mon. ☐ Tues. ☐ Wed. ☐ Thurs. ☐ Fri. ☐ Sat. ☐

B. Did yesterday's meals include any special or unusual event, e.g., party, birthday, anniversary, picnic, etc.? Yes ☐ No ☐ 1. If yes, what was it? _____

C. Does the above represent your usual day's food intake? Yes ☐ No ☐

1. If no, how did it differ from your usual intake? _____

D. Check the column which indicates the approximate frequency with which you consume each food.

Food	Daily	Weekly	Never	Food	Daily	Weekly	Never
Whole milk				Fish			
Cream or half and half				Beef			
Ice cream (not ice milk)				Cream or custard pies			
Cheese (other than cottage)				Cream puddings			
Butter				Sugar: in coffee, tea, etc			
Margarine				Sugar: on cereal			
Sour cream				Sugar: on fruits, vegetables			
Salad dressings (not low calorie)				Frosted cakes, brownies,			
Eggs				sweet rolls, etc			
Gravy				Soft drinks (other than			
Fat around meat				low or non-calorie)			
Pork				Honey			
Veal				Jelly, jam, preserves, marmalade			
French-fried potatoes				Syrups (on pancakes, waffles, etc.)			
Fried meat, fried potatoes, etc				Molasses			
Other deep-fat fried foods				Sweetened fruit juices, syrups, etc			

E. Do you drink coffee? Yes ☐ No ☐ (If yes, answer question A; if no, go on to question 8)
A. What is the average number of cups per day? 1-3 ☐ 4-6 ☐ 7-9 ☐ *more* ☐

SMOKING HABITS

8. Do you smoke at the present time? Yes ☐ No ☐ (If yes to question 8 answer A and B; if no, answer C)

A. What is the average number of cigarettes ___, cigars ___, and/or pipefulls ___ you smoke per day?
B. Have you stopped at any time between 1968 and now? Yes ☐ No ☐ If yes, how long did you stop? _____

C. Did you smoke regularly any time between 1968 and now? Yes ☐ No ☐ If no, go on to question 9.
If yes, how long? _____ How many cigarettes ___, cigars ___, pipefulls ___ did you smoke per day?

DRINKING HABITS

9. Do you drink alcoholic beverages at the present time? Yes ☐ No ☐ (If yes to question 9, answer A and B: if no, answer C)

A. Please check the amounts you usually drink.

Beer	Wine	Liquor
☐ Occasional bottle	☐ Occasional glass other than for religious use	☐ Occasional glass
☐ 1 to 3 bottles per day	☐ Daily, but less than ½ bottle	☐ 3 to 6 shots per day
☐ over 3 bottles per day	☐ Over ½ bottle per day	☐ over 6 shots per day

B. Had you stopped drinking at any time between 1968 and now? Yes ☐ No ☐ If no, go on to question 10. If yes, for how long a period did you stop? _____

C. Did you drink regularly at any time between 1968 and now? Yes ☐ No ☐
If no, go on to question 10. If yes, for how long a period did you drink? _____
How much? (Please check the amounts.)

Beer	Wine	Liquor
☐ Occasional bottle	☐ Occasional glass other than for religious use	☐ Occasional glass
☐ 1 to 3 bottles per day	☐ Daily, but less than ½ bottle	☐ 3 to 6 shots per day
☐ over 3 bottles per day	☐ Over ½ bottle per day	☐ over 6 shots per day

HEREDITARY HISTORY

10. As of 1968, the individuals listed were still alive. Will you please bring this information up-to-date.

RELATIONSHIP	If Living		If Deceased	
	Age	Ailment, if any	Age at Death	Cause of Death

A. Father's occupation (when working) _____

MEDICAL HISTORY

11. In 1968 you indicated you had the following conditions. Will you please bring this information up-to-date. Make any correction or addition in the data we listed below.

Ailment	Age at Onset	Are you still troubled with this condition?		Are you taking medication or treatment for it?	
		Yes	No	Yes	No
High Blood Pressure	_____	☐	☐	☐	☐
Angina Pectoris	_____	☐	☐	☐	☐
Stroke (Cerebral Thrombosis)	_____	☐	☐	☐	☐
Heart Attack (Coronary Thrombosis)	_____	☐	☐	☐	☐
Rheumatic Heart Disease	_____	☐	☐	☐	☐
Cancer	_____	☐	☐	☐	☐
Diabetes	_____	☐	☐	☐	☐
Tuberculosis	_____	☐	☐	☐	☐
Ulcer	_____	☐	☐	☐	☐
Liver Ailment	_____	☐	☐	☐	☐
Arthritis	_____	☐	☐	☐	☐
Gout	_____	☐	☐	☐	☐
Other	_____	☐	☐	☐	☐

Serial No._____

FOURTH FOLLOW-UP OF THE LONGEVITY
AND MORBIDITY OF MALE GRADUATES OF MICHIGAN STATE UNIVERSITY

Name of Alumnus_____ Date_____

Street_____ City_____ State_____

Social Security Number_____

PERSONAL INFORMATION

1. Have there been any changes in your marital status since 1976 (our previous follow-up)?
Yes ☐ No ☐
(If yes to question 1, answer A; if no, move on to question 2)

A. Please Explain_____

2. Present weight____lbs. Have you lost 15 lbs. or more since 1976? Yes ☐ No ☐

OCCUPATIONAL INFORMATION

3. Are you presently working (job or self employed)? Yes ☐ No ☐
(If no, answer A; if yes, move on to question 4)

A. Have you had a job or been self employed at any time since 1976? Yes ☐ No ☐
(If no, answer A; if yes, more on to question 4)

4. Is this the same job you reported on the 1976 questionnaire? Yes ☐ No ☐
(If yes, move on to question 5; if no, answer the following questions A through J.

A. What kind of work (for example, engineer, teacher, doctor) _____

B. About how much time on the job is spent sitting?
Practically all ☐ More than half ☐ About half ☐ Almost none ☐

C. About how much time on the job is spent walking?
Practically all ☐ More than half ☐ About half ☐ Almost none ☐

D. Do you ever walk to or from work? Yes ☐ No ☐
If yes, how far do you walk? Blocks____ Miles____ How many times a year_____
Do you ever bicycle to and from work? Yes ☐ No ☐ If yes, how far do you cycle (both ways)?
Blocks____ Miles____ Number of times per year_____

E. What type of transportation do you use to and from your job (check all that apply)?
Subway ☐ Bus ☐ Car ☐ Bicycle ☐ Walking ☐ Others (Please describe)_____

F. How often do you have to lift heavy weights or carry heavy things on the job?
Frequently ☐ Sometimes ☐ Very infrequently (or never) ☐

G. How many hours a week do you work on your job?____ (Hours per week)

H. How much tension in your job? Great deal ☐ Some ☐ Very little ☐ None ☐

I. Any responsibility for supervising other workers on the job? Yes ☐ No ☐
(If yes, answer 1; if no, move on to J)

1. About how many on the average do you supervise?_____

J. When did you start on this job? Year_____

LEISURE TIME ACTIVITIES

5. How many hours a month do you do the following activities and which months? (List number of hours involved in each activity under the month(s) you participate. Leave blank where not involved.)

ACTIVITY	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Fishing - bank, boat, ice												
Fishing - wading												
Archery, target												
Badminton												
Baseball - hard, soft												
Basketball												
Bicycling - pleasure												
Tobagganing, sledding												
Bowling, including lawn												
Canoeing or rowing												
Jogging												
Curling												
Fencing												
Gardening												
Lawn mowing - riding												
Lawn mowing - power mower												
Lawn mowing - hand mower												
Snow shoveling												
Golf - walking												
Golf - power cart												
Handball, including paddleball, racket and squash												
Walking - back packing												
Walking - cross country												
Walking - mountain climbing												
Walking - pleasure												
Home workshop (carpentry)												
Horseback riding												
Horseshoe pitching												
Hunting - bow and gun												
Sailing - ice and water												
Judo, including karate												
Paddle tennis												
Rowing, skulling												
Shuffleboard (not hand)												
Skating - ice, roller												
Skiing - downhill												
Skiing - cross country												
Skiing - water												
Snowshoeing												
Dancing - ballroom												
Dancing - square												
Swimming - pleasure												
Swimming - exercise												
Table tennis												
Tennis - singles												
Tennis - doubles												
Volleyball												
Weight lifting												
Calisthenics - home												
Calisthenics - Health Club												
Others.												

6. If you have been routinely exercising under a home exercise plan or Health Club plan (commercial, Y.M.C.A., Athletic Club, etc.) answer the following questions:

A. Number of hours per month _____, which months (circle): Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.

B. What type of exercises? _____

DIET RECALL

7. List the things you ate and drank yesterday (this should preferably be a week day). When possible, give the specific name of the item, e.g., Fresca or Coca Cola, rather than soft drink; McDonald's hamburger; whole milk, skim milk, half and half, rather than just milk. Indicate the amount you ate or drank in terms of cups (200 ml), tablespoons, teaspoons, ounces, numbers and approximate size, e.g., small, large, medium for fruits, vegetables, etc.

You may list meats either in ounces or size of pieces: one hamburger patty (3" diameter x 1" thick) weighs 3 oz.; an average serving of steak (3" x 3" x ½") weighs 3 oz. Be sure to include everything you ate or drank yesterday — candy, liquor, coffee (list sugar and cream, if used), popcorn, potato chips, etc., as well as your regular meals. To help you estimate sizes, a rule is marked off on the edge of this page.

Breakfast		Morning Snacks	
Item	Amount or Size	Item	Amount or Size
Lunch		**Afternoon Snacks**	
Item	Amount or Size	Item	Amount or Size
Dinner		**Evening Snacks**	
Item	Amount or Size	Item	Amount or Size

A. Check date of diet record: Sun. ☐ Mon. ☐ Tues. ☐ Wed. ☐ Thurs. ☐ Fri. ☐ Sat. ☐

B. Did yesterday's meals include any special or unusual event, e.g., party, birthday, anniversary, picnic, etc.? Yes ☐ No ☐ 1. If yes, what was it? _____

C. Does the above represent your usual day's food intake? Yes ☐ No ☐

1. If no, how did it differ from your usual intake? _____

D. Check the column which indicates the approximate frequency with which you consume each food.

Food	Daily	Weekly	Never	Food	Daily	Weekly	Never
Whole milk				Fish			
Cream or half and half				Beef			
Ice cream (not ice milk)				Cream or custard pies			
Cheese (other than cottage)				Cream puddings			
Butter				Sugar, in coffee, tea, etc.			
Margarine				Sugar, on cereal			
Sour cream				Sugar, on fruits, vegetables			
Salad dressings (not low calorie)				Frosted cakes, brownies,			
Eggs				sweet rolls, etc			
Gravy				Soft drinks (other than			
Fat around meat				low or non-calorie)			
Pork				Honey			
Veal				Jelly, jam, preserves, marmalade			
French-fried potatoes				Syrups (on pancakes, waffles, etc.)			
Fried meat, fried potatoes, etc				Molasses			
Other deep-fat fried foods				Sweetened fruit juices, syrups, etc			

E. Do you drink coffee? Yes ☐ No ☐ (If yes, answer question A; if no, go on to question 8)
A. What is the average number of cups per day? 1-3 ☐ 4-6 ☐ 7-9 ☐ more ☐

SMOKING HABITS

8. Do you smoke at the present time? Yes ☐ No ☐ (If yes to question 8 answer A and B; if no, answer C)

A. What is the average number of cigarettes ___, cigars ___, and/or pipefulls ___ you smoke per day?
B. Have you stopped at any time between 1976 and now? Yes ☐ No ☐ If yes, how long did you stop? _____

C. Did you smoke regularly any time between 1976 and now? Yes ☐ No ☐ If no, go on to question 9.
If yes, how long? _____ How many cigarettes ___, cigars ___, pipefulls ___ did you smoke per day?

DRINKING HABITS

9. Do you drink alcoholic beverages at the present time? Yes ☐ No ☐ (If yes to question 9, answer A and B: if no, answer C)

A. Please check the amounts you usually drink.

Beer	Wine	Liquor
☐ Occasional bottle	☐ Occasional glass other than for religious use	☐ Occasional glass
☐ 1 to 3 bottles per day	☐ Daily, but less than ½ bottle	☐ 3 to 6 shots per day
☐ over 3 bottles per day	☐ Over ½ bottle per day	☐ over 6 shots per day

B. Had you stopped drinking at any time between 1976 and now? Yes ☐ No ☐ If no, go on to question 10. If yes, for how long a period did you stop? _____

C. Did you drink regularly at any time between 1976 and now? Yes ☐ No ☐
If no, go on to question 10. If yes, for how long a period did you drink? _____
How much? (Please check the amounts.)

Beer	Wine	Liquor
☐ Occasional bottle	☐ Occasional glass other than for religious use	☐ Occasional glass
☐ 1 to 3 bottles per day	☐ Daily, but less than ½ bottle	☐ 3 to 6 shots per day
☐ over 3 bottles per day	☐ Over ½ bottle per day	☐ over 6 shots per day

HEREDITARY HISTORY

10. As of 1976, the individuals listed were still alive. Will you please bring this information up-to-date.

RELATIONSHIP	If Living		If Deceased	
	Age	Ailment, if any	Age at Death	Cause of Death

A. Father's occupation (when working) _____

MEDICAL HISTORY

11. In 1976 you indicated you had the following conditions. Will you please bring this information up-to-date. Make any correction or addition in the data we listed below.

Ailment	Age at Onset	Are you still troubled with this condition?		Are you taking medication or treatment for it?	
		Yes	No	Yes	No
High Blood Pressure	_____	☐	☐	☐	☐
Angina Pectoris	_____	☐	☐	☐	☐
Stroke (Cerebral Thrombosis)	_____	☐	☐	☐	☐
Heart Attack (Coronary Thrombosis)	_____	☐	☐	☐	☐
Rheumatic Heart Disease	_____	☐	☐	☐	☐
Cancer	_____	☐	☐	☐	☐
Diabetes	_____	☐	☐	☐	☐
Tuberculosis	_____	☐	☐	☐	☐
Ulcer	_____	☐	☐	☐	☐
Liver Ailment	_____	☐	☐	☐	☐
Arthritis	_____	☐	☐	☐	☐
Gout	_____	☐	☐	☐	☐
Other	_____	☐	☐	☐	☐

APPENDIX C

STATISTICAL ANALYSES

Two-sample t-tests

VARIABLE	ATHLETE	YES	NO	TEST STATISTIC	DF	SIGNIF
4.	MEAN	68.204	70.167	T=-1.6141	499	.1071
AGEDX	VAR	178.30	190.07	F= 1.0660	226,273	.3063
(TOTAL= 1193)	N	274	227	PROB(1ST MEAN<2ND DATA)=		.9455
10.	MEAN	2.6558	2.7561	T=-.98678	765	.3241
ENDO	VAR	1.9089	2.0545	F= 1.0763	368,397	.2360
(TOTAL= 1183)	N	398	369	PROB(1ST MEAN<2ND DATA)=		.8373
11.	MEAN	4.9698	4.5691	T= 3.5990	765	.0003
MESO	VAR	2.3971	2.3492	F= 1.0204	397,368	.4223
(TOTAL= 1183)	N	398	369	PROB(1ST MEAN>2ND DATA)=		.9998
12.	MEAN	2.6633	3.0271	T=-4.5110	765	.0000
ECTO	VAR	1.2063	1.2873	F= 1.0672	368,397	.2622
(TOTAL= 1183)	N	398	369	PROB(1ST MEAN<2ND DATA)=		1.0000

DESCRIPTIVE STATISTICS FOR FIXED COVARIATES

VARIABLE NO.	NAME	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	SKEWNESS	KURTOSIS
1	ATHYN	1.0000	2.0000	1.4011	0.5000	0.08	1.00
2	ENDO	1.0000	7.0000	2.7040	1.4067	0.24	1.93
3	MESO	1.0000	7.0000	4.7771	1.5527	-0.27	2.19
4	ECTO	1.0000	6.0000	2.8383	1.1299	0.16	2.20

STATUS CODE FREQUENCIES

TOTAL	DEAD	LOST 1	LOST 2	PERCENT CENSORED
767	318	357	92	0.5854

INDEPENDENT VARIABLES
1 ATHYN 2 ENDO 3 MESO 4 ECTO

LOG LIKELIHOOD = -1744.5437
GLOBAL CHI-SQUARE = 24.47 D.F.= 4 P-VALUE =0.0001

VARIABLE	COEFFICIENT	STANDARD ERROR	COEFF./S.E.	EXP(COEFF.)
1 ATHYN	-0.1233	0.1154	-1.0685	0.8840
2 ENDO	0.0098	0.0831	0.1181	1.0099
3 MESO	-0.1751	0.0927	-1.8887	0.8393
4 ECTO	-0.2867	0.0746	-3.8424	0.7507

*** EFFECTS TESTED ***
1 ATHYN

STATISTIC	CHI-SQUARE	D.F.	P-VALUE
WALD	1.14	1	0.2853

DESCRIPTIVE STATISTICS FOR FIXED COVARIATES

VARIABLE NO. NAME	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION	SKEWNESS	KURTOSIS
1 ATHYN	1.0000	2.0000	1.4811	0.5000	0.08	1.00

STATUS CODE FREQUENCIES

TOTAL	DEAD	LOST 1	LOST 2	PERCENT CENSORED
767	318	357	92	0.5054

1PAGE 4 BMDP2L HYPOTHESIS 3-B

INDEPENDENT VARIABLES
1 ATHYN

LOG LIKELIHOOD = -1755.2924
GLOBAL CHI-SQUARE = 1.72 D.F.= 1 P-VALUE =0.1894

VARIABLE	COEFFICIENT	STANDARD ERROR	COEFF./S.E.	EXP(COEFF.)
1 ATHYN	-0.1487	0.1134	-1.3113	0.8618

1PAGE 5 BMDP2L HYPOTHESIS 3-B

[illegible]

Univariate 1-way ANOVA

ANALYSIS OF VARIANCE OF 72.LIFETIME N= 767 OUT OF 767

SOURCE	DF	SUM OF SQRS	MEAN SQR	F-STATISTIC	SIGNIF
BETWEEN	3	1540.8	513.60	7.2339	.0001
WITHIN	763	54148.	70.967		
TOTAL	766	55689.	(RANDOM EFFECTS STATISTICS)		

ETA= .1663 ETA-SQR= .0277 (VAR COMP= 3.1220 %VAR AMONG= 4.21)

SOMAT	N	MEAN	VARIANCE	STD DEV
ENDO	121	72.331	70.023	8.3680
MESO	483	76.302	69.987	8.3658
ECTO	61	75.311	81.051	9.0029
BALANC	102	75.863	70.773	8.4127
GRAND	767	75.538	72.701	8.5265

PAIRWISE STRATA	MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES LEV=.9500
ENDO				
MESO	-3.9717	21.508	.0000	2.3994
ECTO	-2.9809	5.0779	.0245	3.7062
BALANC	-3.5322	9.7299	.0019	3.1726
MESO				
ECTO	.99080	.74920	.3870	3.2071
BALANC	.43953	.22935	.6322	2.5719
ECTO				
BALANC	-.55127	.16346	.6861	3.8202

ANOVA V=72 S=014 C=0211 COMB=ALLPAIRS LEVELS=.95

Univariate 1-way ANOVA CASES=ATH.ETE:YES

ANALYSIS OF VARIANCE OF 72.LIFETAGE N= 398 OUT OF 398

SOURCE	DF	SUM OF SQRS	MEAN SQR	F-STATISTIC	SIGNIF
BETWEEN	3	1044.0	348.00	5.3753	.0012
WITHIN	394	25507.	64.740		
TOTAL	397	26551.	(RANDOM EFFECTS STATISTICS)		

ETA= .1983 ETA-SQR= .0393 (VAR COMP= 4.3929 %VAR AMONG= 6.35)

SOMAT	N	MEAN	VARIANCE	STD DEV
ENDO	58	71.621	59.608	7.7206
MESO	275	76.055	65.869	8.1160
ECTO	20	76.850	47.818	6.9151
BALANC	45	76.556	71.662	8.4653
GRAND	398	75.505	66.880	8.1780

PAIRWISE STRATA	MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES LEV=.9500
ENDO				
MESO	-4.4339	14.545	.0002	3.2641
ECTO	-5.2293	6.2817	.0126	5.8529
BALANC	-4.9349	9.5320	.0022	4.4877
MESO				
ECTO	-.79545	.18222	.6692	5.2318
BALANC	-.50101	.14994	.6980	3.6327
ECTO				
BALANC	.29444	.18542 -1	.8918	6.0710

Comp.PRF
[illegible] LEVEL=.95

Univariate 1-way ANOVA (ASSESS=ATHLETIC)

ANALYSIS OF VARIANCE OF ATHLETIC N= 365 OUT OF 369

SOURCE	DF	SUM OF SQRS	MEAN SQR	F-STATISTIC	SIGNIF
BETWEEN	3	700.31	233.44	2.9964	.0308
WITHIN	365	28436.	77.907		
TOTAL	368	29136.	(RANDOM EFFECTS STATISTICS)		

ETA= .1550 ETA-SQR= .0240 (VAR COMP= 2.0497 %VAR AMONG= 2.56)

SOMAT	N	MEAN	VARIANCE	STD DEV
ENDO	63	72.984	79.822	8.9343
MESO	208	76.630	75.587	8.6941
ECTO	41	74.561	97.102	9.8541
BALANC	57	75.316	70.648	8.4053
GRAND	369	75.575	79.174	8.8980

PAIRWISE STRATA	MULTIPLE COMPARISON DIFF	F-STAT	SIGNIF	SCHEFFE ALLOWANCES LEV=.9500
ENDO				
MESO	-3.6457	8.2493	.0043	3.5650
ECTO	-1.5768	.79268	.3739	4.9742
BALANC	-2.3317	2.0883	.1493	4.5316
MESO				
ECTO	2.0688	1.8816	.1710	4.2359
BALANC	1.3140	.99156	.3200	3.7062
ECTO				
BALANC	-.7548[illegible]	.17440	.6765	5.0764

```
 Command
1MCORREL V=72,79-82 C=V13
 STATS correlation
=DONE
```

Pearson Data Correlation CASES=500nAT

VARIABLE	MEAN	STD DEV	N	CORR	T-STAT	SIGNIF
72.LIFETAGE	75.486	8.5764	729	.0055	.14705	.8816
79.HTBY3RWT	12.943	.48380				
72.LIFETAGE	75.486	8.5764	729	-.0849	-1.4833	.1384
80.WTBYHT2	.32540 -1	.35119 -2				
72.LIFETAGE	75.486	8.5764	729	-.0947	-2.5642	.0105
81.WTBYHT	2.2677	.25806				
72.LIFETAGE	75.486	8.5764	729	-.0089	-.23991	.8105
82.WTBYHT3	.46755 -3	.53766 -4				
79.HTBY3RWT	12.943	.48380	729	-.9418	-75.530	0.
80.WTBYHT2	.32540 -1	.35119 -2				
79.HTBY3RWT	12.943	.48380	729	-.7870	-34.400	0.
81.WTBYHT	2.2677	.25806				
79.HTBY3RWT	12.943	.48380	729	-.9925	-218.56	0.
82.WTBYHT3	.46755 -3	.53766 -4				
80.WTBYHT2	.32540 -1	.35119 -2	729	.9453	78.147	0.
81.WTBYHT	2.2677	.25806				
80.WTBYHT2	.32540 -1	.35119 -2	729	.9444	77.447	0.
82.WTBYHT3	.46755 -3	.53766 -4				
81.WTBYHT	2.2677	.25806	729	.7850	34.253	0.
82.WTBYHT3	.46755 -3	.53766 -4				

```
;
> PEARSON DATA=DATA VAR=72,79-82 STRAT=V2;
-Missing Data Correlation  <1> ATHLETE:YES
-      VARIABLE          MEAN        STD DEV          N      CORR   T-STAT     SIGNIF
0   72.LIFETAGE         75.484       8.3209         384    .0370   .72455      .4692
9   79.HTBY3RWT         12.843       .45676
0   72.LIFETAGE         75.484       8.3209         384   -.0916 -1.7978       .0730
9   80.WTBYHT2          .33375 -1  .34780 -2
0   72.LIFETAGE         75.484       8.3209         384   -.1363 -2.6887       .0075
9   81.WTBYHT           2.3328       .26473
0   72.LIFETAGE         75.484       8.3209         384   -.0331 -.64738       .5176
9   82.WTBYHT3          .47813 -3  .51314 -4
0   79.HTBY3RWT         12.843       .45676         384   -.9327 -50.533       0.
9   80.WTBYHT2          .33375 -1  .34780 -2
0   79.HTBY3RWT         12.843       .45676         384   -.7716 -23.704       .0000
9   81.WTBYHT           2.3328       .26473
0   79.HTBY3RWT         12.843       .45676         384   -.9954 -203.36       0.
9   82.WTBYHT3          .47813 -3  .51314 -4
0   80.WTBYHT2          .33375 -1  .34780 -2      384    .9471   57.702       0.
9   81.WTBYHT           2.3328       .26473
0   80.WTBYHT2          .33375 -1  .34780 -2      384    .9395   53.591       0.
9   82.WTBYHT3          .47813 -3  .51314 -4
0   81.WTBYHT           2.3328       .26473         384    .7801   24.368       0.
9   82.WTBYHT3          .47813 -3  .51314 -4
-Missing Data Correlation  <2> ATHLETE:NO
-      VARIABLE          MEAN        STD DEV          N      CORR   T-STAT     SIGNIF
0   72.LIFETAGE         75.556       8.9423         354   -.0419 -.78660       .4320
9   79.HTBY3RWT         13.034       .50926
0   72.LIFETAGE         75.556       8.9423         354   -.0088 -.16510       .8690
9   80.WTBYHT2          .31738 -1  .34377 -2
0   72.LIFETAGE         75.556       8.9423         354   -.0558 -1.0478       .2955
9   81.WTBYHT           2.2016       .23469
0   72.LIFETAGE         75.556       8.9423         354    .0333   .62489      .5324
9   82.WTBYHT3          .45821 -3  .57411 -4
0   79.HTBY3RWT         13.034       .50926         354   -.9512 -57.841       0.
9   80.WTBYHT2          .31738 -1  .34377 -2
0   79.HTBY3RWT         13.034       .50926         354   -.7837 -23.670       .0000
9   81.WTBYHT           2.2016       .23469
0   79.HTBY3RWT         13.034       .50926         354   -.9882 -120.79       0.
9   82.WTBYHT3          .45821 -3  .57411 -4
0   80.WTBYHT2          .31738 -1  .34377 -2      354    .9310   47.851       0.
9   81.WTBYHT           2.2016       .23469
0   80.WTBYHT2          .31738 -1  .34377 -2      354    .9467   55.114       0.
9   82.WTBYHT3          .45821 -3  .57411 -4
0   81.WTBYHT           2.2016       .23469         354    .7641   22.222       .0000
9   82.WTBYHT3          .45821 -3  .57411 -4
-FINISH
```

```
 Command
?TWOWAY V=14,57 C=V57:1,2*V14 O=COL%,TESTS

 Twoway Cross-Tabulation  CASES=CVDX76:YES,OTHRDX*SOMAT

 57.                14.SOMAT
 CVDX76             ENDO    MESO    ECTO BALANC

      N=   134
 TOTAL=    134      21      88       5      20
   COL%

    YES     72      11      47       4      10
   COL%   53.7    52.4    53.4    80.0    50.0

OTHRDX      62      10      41       1      10
   COL%   46.3    47.6    46.6    20.0    50.0

 TESTS OF INDEPENDENCE  STATISTIC  SIGNIF  DF= 3      N= 134

   MAXIMUM LIKELIHOOD    1.6375     .6509  CRAMER'S PHI=        .1065
   CHI-SQUARE            1.5189     .6779  CONTINGENCY COEFF=   .1059


 Command
?TWOWAY V=14,58 C=V58:1,2*V14 O=COL%,TESTS

 Twoway Cross-Tabulation  CASES=CADX76:YES,OTHRDX*SOMAT

 58.                14.SOMAT
 CADX76             ENDO    MESO    ECTO BALANC

      N=   134
 TOTAL=    134      21      88       5      20
   COL%

    YES     32       7      19       1       5
   COL%   23.9    33.3    21.6    20.0    25.0

OTHRDX     102      14      69       4      15
   COL%   76.1    66.7    78.4    80.0    75.0

 TESTS OF INDEPENDENCE  STATISTIC  SIGNIF  DF= 3      N= 134

   MAXIMUM LIKELIHOOD    1.2726     .7357  CRAMER'S PHI=        .1000
   CHI-SQUARE            1.3413     .7194  CONTINGENCY COEFF=   .0996
```

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