This is to certify that the

thesis entitled

DIET AND LIFESTYLE VARIABLES AS
DETERMINANTS OF SURVIVAL IN FORMER
COLLEGE ATHLETES AND NON-ATHLETE CONTROLS

presented by

Mary Louise Sunman

has been accepted towards fulfillment
of the requirements for

MASTER OF SCIENCE degree in Department of Food Science and Human Nutrition

Sharon L Hoerr, PhD
Major professor

Date 8/7/97

DIET AND LIFESTYLE VARIABLES AS DETERMINANTS OF SURVIVAL IN FORMER COLLEGE ATHLETES AND NON-ATHLETE CONTROLS

By

Mary Louise Sunman

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Food Science and Human Nutrition

1987

ABSTRACT

DIET AND LIFE-STYLE VARIABLES AS DETERMINANTS OF SURVIVAL IN FORMER COLLEGE ATHLETES AND NON-ATHLETE CONTROLS

By

Mary Louise Sunman

The purpose of this investigation was to determine if former college athletes and their controls differed in body mass index, energy intake, fat intake, smoking habits and aerobic activity, and whether these variables, together with participation in college athletics, predicted years of survival. The sample studied consisted of 336 white male alumni who attended college prior to 1938. The sample was surveyed by mail with five health and life-style questionnaires between 1952 and 1985. Food frequency questionnaires and 24-hour recalls were included in the last three surveys. Results showed that more former athletes than controls were smokers in 1952, and that former athletes consumed more Kcals/day than controls in 1985. The Cox Proportional Hazards Regression Model showed that aerobic activity was a significant predictor of survival. Subjects who survived later than 1985 were more aerobically active than those who died at an earlier date.

ACKNOWLEDGEMENTS

I would like to express my gratitude to Dr.Sharon Hoerr, my advisor and chairperson, for her invaluable help and guidance throughout my two years at Michigan State University. Drs. Chenoweth, Schemmel and Olson provided help and insight in their capacity as committee members. Particular thanks are due to Dr. Homer Sprague for statistical guidance.

My studies would not have been possible without two years of support from the Fulbright Commission, and a grant from the British Universities North America Club. I would like to thank Dr. Dutson for arranging financial assistance through the Michigan Agricultural Experiment Station.

I am indebted to Ron Carda for sharing his knowledge of the Michigan State longevity study, and to Richard Ivans for help with the Nutrient Database. Jon Alley and Karen Ellerman both contributed by coding dietary recalls, and Katie Richards patiently and accurately transcribed my scribblings. I would like to thank my husband, Roy, who provided moral support and technical assistance.

TABLE OF CONTENTS

LIST OF TABLES.

LIST OF FIGURES

INTRODUCTION

Improvements in lifestyle, including nutritional status, are accepted as being influential in the increased longevity that has occurred during the last century. Lifestyle variables are also blamed for the concomitant increase in the incidence of death from degenerative diseases such as cancer and heart disease (Morrison, 1983). This apparent paradox might be explained by human survival curves. It is apparent that although average life expectancy has increased, it is due to more people living longer rather than due to an increase in the maximum life span as is seen in animal models (Yu, Masoro, Murata, Bertrand and Lynd, 1982). In other words, the maximum age obtained in the population does not increase, but the increased numbers of people approaching this maximum age increases average longevity (Morrison, 1983).

It is clear that any mechanism hypothesized to explain the relationship between lifestyle and longevity in an animal model will describe different phenomena from that observed in human populations. For example, attempts to

explain the relationship between energy intake and longevity in humans must be based on data from human populations and measure also a wide range of possible contributing or confounding lifestyle variables.

The aim of this investigation is to assess body mass index, total energy intake, percent kilocalories from fat, smoking habits and participation in college sports and subsequent physical activity as predictors of life expectancy in a sample of male college graduates who have been followed longitudinally for 33 years.

REVIEW OF THE LITERATURE

Mortality Statistics and Trends

Data from the United States Bureau of the Census indicate that life expectancy for US residents has been increasing steadily since 1900 (US Department of Commerce, 1984). More specifically, life expectancy for white males has increased from 46.6 years at birth in 1900, to 71.8 years at birth in 1984 (National Center for Health Statistics, 1985). In Michigan, life expectancy for men of all races was 71.2 years at birth in 1985 (Michigan Department of Public Health, 1987).

Parallel to the increase in life expectancy has been a decrease in the death rate (number of deaths per

1000 of the population, excluding fetal deaths). The death rate for white males in the U.S. has decreased from 17.7 in 1900 to 10.9 in 1970. The estimated death rate for white males in 1985-86 was 9.6 per 1000 population (National Center for Health Statistics, 1987). Leading causes of death in 1985 were major cardiovascular disease, which accounted for 45.8% of all deaths, and malignant neoplasms, accounting for 22.6% of deaths.

Improvements in lifestyle, including nutritional status, are accepted as being influential in both the increased life expectancy and the rise of degenerative diseases such as cancer and heart disease which have occurred over the last century (Morrison, 1983). The following review focuses specifically on the relationship between body weight, selected dietary variables (fat and kilocalories), and physical activity to mortality and longevity.

The Relationship Between Body Mass Index and Mortality

Body weight and body fatness have been used by epidemiologists and actuaries to predict longevity and future occurrence of disease. A comparison of studies relating body weight and body fatness to longevity is confounded by the use of:

1) Different methods and analytical techniques:
2) Differences in the weight indicies;
3) Age of the study population: and
4) Endpoints to which body weight was related.

Also, the recognition of the confounding effects of covariables such as smoking and physical activity on the relationship between body weight and mortality has led to increasingly sophisticated statistical analyses in recent years and to reworking of the data sets of previous studies, often with new conclusions.

A summary of the studies reviewed relating body mass index (BMI) and mortality is presented in Table 1. These are longitudinal studies in which BMI was related directly to mortality in large North American or European populations. These will be discussed according to the weight-mortality relationships found: no relationship or linear and non-linear relationships.

Studies in Which No Relationship Was Found Between Body Weight, Body Fatness and Mortality.

In only one study, the Seven Countries Study, was no relationship found between BMI and mortality (Keys et al., 1981). However follow-up was restricted to ten years, cigarette smoking was not considered, and the population studied was not from the United States. The

Table 1.

Summary of the studies reviewed relating mortality and BMI.

Study	No.Men	No. Women	Deaths	Yrs follow up	Age at entry	Smoking consid.	Popul-ation	Wt/mort. relation found*
Seven Country	11,250	0	1247	10	40-59	No	European	None
Build & B.P.	3,700, 000	500, 000	106, 000	6.6	15-69	No	U.S.	Linear
Manitoba	3983	0	199	26	25-34	No	Pilots	Linear
White-hall	18393	0	1722	10	40-64	Yes	British	"J"
Framing han	1977	0	729	26	30-62	Yes	Original	"U"
Vanden-broucke	1503	1464	n/a	25	40-65	Yes	Dutch	"U"
Chicago Peoples Gas	1233	0	246	14	40-59	Yes	U.S.	"U"
American Cancer	336, 000	419, 000	107, 000	6	>30	Yes	U.S.	"U"

* For definitions of J-shaped" and "U-shaped" relationships, see page 7, and Figure 1.

National Center for Health Statistics (NCHS) has carried out three major national health surveys, in 1960, 1971 and 1976. Trends of increasing BMI with decreasing mortality in these surveys would appear to refute a positive relationship between these two variables found in other studies. However in the analyses of these surveys by NCHS, the effects of confounders were not considered (Feinleib, 1985).

Studies in Which a Relationship was Found Between Body Weight, Body Fatness and Mortality.

Linear relationships.

In two studies of large samples, linear relationships were found between weight and mortality. In the 1959 Build and Blood Pressure Study, a continuous and direct relationship between body weight and risk of mortality was reported, with lowest mortality occuring at 15% below the average weight of adults for any particular height (Society of Actuaries, 1959). This linear relationship between body weight and mortality was also found in the 1979 Build and Blood Pressure Study (Build Study 1979).

In the Manitoba Study Rabkin, Matthewson and Hsu (1978) found that initial measurements of BMI were associated positively with the 26-year incidence of ischemic heart disease ($p<0.01$) in a sample of 3983 men

with a mean age at entry of 30.8 years. BMI was found to be a significant predictor of 390 cases of ischemic heart disease after adjustment for the effects of age and blood pressure ($p<0.01$). Longevity was associated positively with a below average BMI. The mortality ratio (observed/expected deaths) was 50% in those with a BMI of less than 22.5, but 200% in those with a BMI greater than 27.6.

"J-shaped" relationships.

A "J" shaped relationship between weight and mortality is one in which the mortality at low weights is higher than that in the mid-range weights but not as high as that in the upper weights. A "J-shaped" relationship is illustrated in Figure 1.

In the Whitehall Study, Jarrett, Shipley and Rose (1982) reported ten-year mortality rates in men aged 40-64 years in relation to BMI at initial examination in 1967. In men aged 40-49 years, mortality increased with increasing BMI. However in men older than 49 years, the highest mortality was seen in those with the lowest BMI. Pooled data from all ages showed a "J-shaped" relationship between mortality and BMI. Increased mortality at low BMI was not explained by cigarette smoking.

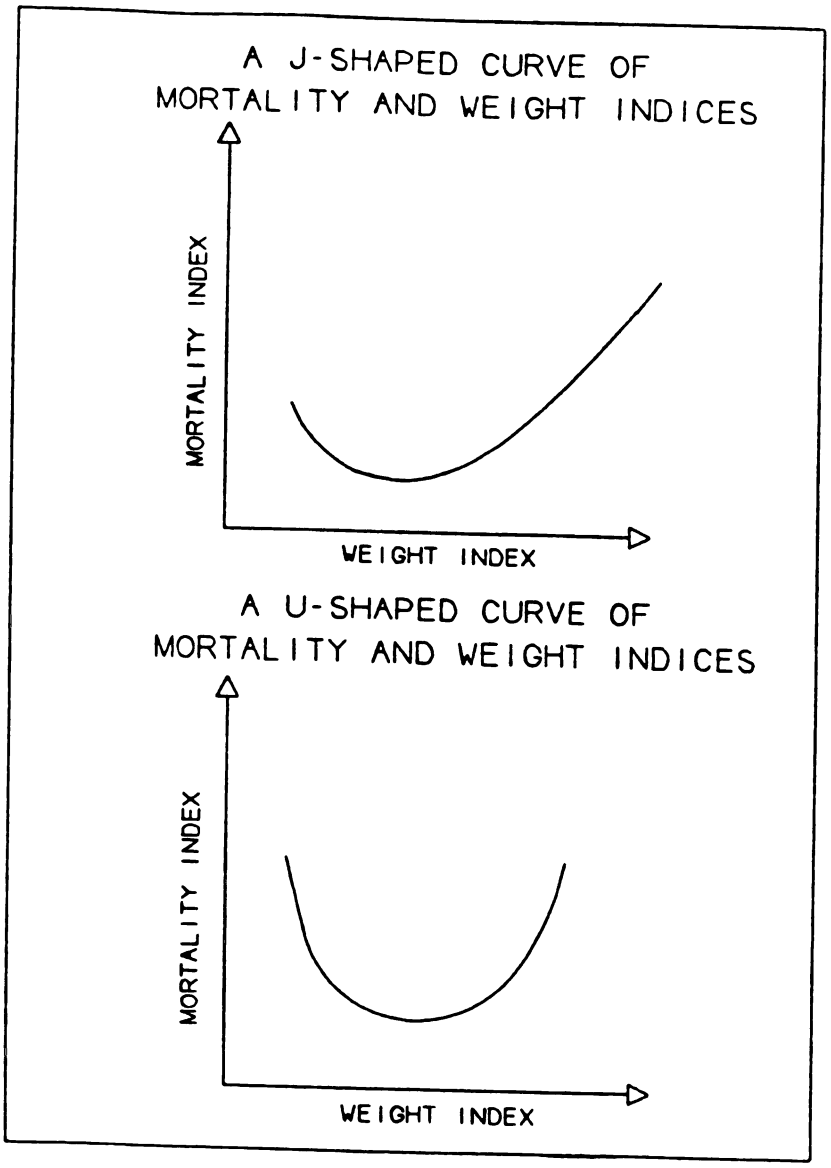

Figure 1. An illustration of J-shaped and U-shaped relationships between weight and mortality.

"U-shaped" relationships.

A "U-shaped" relationship between weight and mortality is one in which mortality at low and high weights are equally high, and both are higher than mortality at the middle range of weights. A "U-shaped" relationship is illustrated in Figure 1.

In 1980 Sorlie, Gordon and Kannel reported the findings of an analysis of the 24-year, follow-up data from the Framingham Study. They found a "U-shaped" curve of mortality risk against body weight, with minimum mortality at the average weight of the group. The increased risk of mortality with low body weight remained after correction for the significant association of low body weight with high, short-term mortality from chronic disease. The increased proportion of lean persons who smoked did not account entirely for the excess mortality in the leanest group. Despite this finding, three years later Garrison, Feileib, Castelli and McNamara (1983) suggested that the increased mortality in low weight men seen in the Framingham Study was a reflection of the higher proportion of lean men who were cigarette smokers.

Vandenbroucke et al. (1984) in a follow-up of 1503 men aged 40-65 years at the start of the study in 1954, also observed high numbers of smokers in the group with the lowest BMI. Twenty-five year mortality plotted against BMI produced a "U-shaped" curve for both smokers and non-smokers. The shape of the mortality curve did not

change when mortality from the first five years was excluded to reduce the effect of chronic disease undetected at the srart of the study.

In a 14-year longitudinal study, Dyer, Stamler, Berkson and Lindberg (1975) examined data from 1233 white male employees of the Chicago Peoples Gas Company, aged 40-59 years at the start of the study in 1958. The relationships between BMI and total mortality, cardiovascular/renal deaths, and coronary heart disease deaths were examined. Variables measured were age, systolic blood pressure, serum cholesterol, and number of cigarettes smoked. Deaths from all causes examined, from cardiovascular/renal disease and from coronary heart disease, were found to have significant quadratic relationships to BMI for the total sample. The level of significance was not reported. When smoking was considered as a variable, BMI continued to show a significant quadratic relationship to all causes of death except coronary heart disease amongst non-smokers. Mortality curves were "U-shaped" with lowest risk of mortality at 25-35% above Ideal Weight (1983 Metropolitan Life Insurance Tables).

In 1959, the American Cancer Society began a follow-up study of 750,000 men and women who were free from disease and who had not reported weight loss at the start of the study. This group was followed until 1973, and the mortality findings analyzed according to variations in

weight by height from the average weight for the population studied (Lew and Garfinkel, 1979). The lowest mortality rates occurred in people weighing 80-89% of the average weight, and who did not smoke cigarettes. Within each category of smoking habits, the lowest total mortality generally occurred in those persons slightly below average weight. Mortality from cancer showed a "U-shaped" curve when plotted against the relative weight index, even when controlling for the effects of cigarette smoking.

Smoking as a confounder to weight-mortality relationships.

In recently published results from the second National Health and Nutrition Examination Survey (NHANES II), smokers have been shown to have a lower mean body mass index than non-smokers in a representative sample of the U.S population. Smokers had a mean BMI of 24.6±0.1, whereas non-smokers had a mean BMI of 25.7±0.1. This difference was significant at $p<.05$ (Albanes, Jones, Micizzi and Mattson, 1987). As discussed previously, many studies of weight-mortality relationships have found differences between smokers and non-smokers (Feinleib, Castelli and McNamara, 1983; Sorlie, Gordon and Kannel, 1980; Vandenbroucke et al., 1984). In these studies, smokers tended to be lighter than non-smokers and to have higher mortality rates. Failing to allow for the effect of smoking on the weight-mortality relationship will therefore increase the weight at which lowest mortality occurs, due

to excess mortality in low weight smokers. Smoking is an important confounder to weight-mortality relationships.

The Relationship Between Dietary Intake and Mortality.

The following review focuses on the relationships between overall diet quality, total kilocalories, and fat intake to mortality. The many epidemiological studies on the relationship of macronutrients to cancer and heart disease mortality are not reviewed here.

Diet Quality and Mortality.

Only two recent investigations have focused on the effect of overall diet quality (as determined by consumption of certain types of foods) to mortality. In a 21-year follow-up study on 27,530 adult Seventh Day Adventists, Kahn, Phillips, Snowdon and Choi (1984) investigated the association between mortality from all causes and frequency of consumption of 28 specific foods. Food consumption was measured in 1960 by a self-administered food frequency questionnaire. Death certificates were subsequently obtained for subjects who died before 1981. All cause mortality (deaths from all causes except violence or trauma) showed a significant negative association at the 0.01 level with green salad consumption. At the same level, all cause mortality showed a significant positive association with meat and egg

consumption. These associations remained significant after adjusting for age, sex, smoking history, chronic disease and age at first exposure to the Adventist church. The total nutrient and calorie composition of the diet was not examined. No further dietary information was obtained after the initial questionnaire, making it impossible to evaluate whether eating habits changed over the follow-up period.

In the second study Nube, Kok, Vandenbroucke, Heide-Weissel and Heide (1987) applied a scoring system to the diets of 2,820 middle-aged Dutch civil servants and their spouses. The interviews were part of a health examination survey in the early 1950's. The diet score was derived from consumption frequency data of 10 food items. These were white bread, brown bread, milk, porridge or yogurt, potatoes, vegetables, meat, fish, eggs and fruit. In 1985, 25-year age adjusted survival was calculated and compared to diet score, with higher scores representing a more "prudent" diet than did low scores. In men, a significant linear trend ($p<0.01$) was found between diet score and 25-year age adjusted survival. However in women, no relationship of diet score to longevity was observed. Again, no nutrient analysis of the dietary intakes was made, and no data were collected on eating habits subsequent to the initial survey. The items selected as representative of a prudent diet did not cover a wide range of foods.

Energy Intake and Mortality.

Total energy intake has been cited as a determinant of longevity in animals, with increased longevity being associated with restricted caloric intake (Yu, Masoro, Murata, Bertrand and Lynd, 1982; "Limited food intake", 1982). However animal models have limited applicability to the complex interrelationships between lifestyle and longevity found in human populations. From human survival curves it is apparent that although average life expectancy has increased, it is due to more people living longer rather than due to an increase in the maximum lifespan as is seen in the animal models. The maximum age obtained in the population does not increase, but the increased numbers of people approaching this maximum age increases average longevity (Morrison, 1983). It is clear that any mechanism hypothesized to explain the relationship between energy intake and longevity in an animal model will describe a different phenomena to that observed in human populations. Attempts to explain the relationship between energy intake and longevity in humans must be based on data from human populations and measure also a wide range of possible contributing or confounding lifestyle variables.

Kushi et al. (1981), reporting data from 1001 middle-aged men, found no significant relationship between energy intake in 1959 and subsequent 20-year mortality from coronary heart disease. Dietary information was obtained by diet history and coded as food frequencies. When

adjusted for age, cigarette smoking, blood pressure and serum cholesterol, energy intake was not a significant predictor of coronary heart disease mortality.

The association of BMI, an indicator of obesity from weight and height measurements alone, with increased mortality risk has been discussed previously. Obesity has been cited as a risk factor for hypertension, hypercholesterolemia and diabetes (Van Itallie, 1985) all of which are conditions considered to contribute to some of the major causes of mortality. However often changes in BMI are assumed to reflect changes in caloric intake, without consideration of other components of energy balance such as the type of energy intake, i.e. fat intake, or the physical activity. This assumption might or might not be valid.

Fat Intake and Mortality.

The results of studies relating fat intake to morbidity and mortality should be interpreted with care, considering the high degree of collinearity between fat and energy intake. There is little evidence linking fat intake directly to total mortality. However high intakes of fat have been linked to both the incidence of coronary heart disease and the incidence of cancer in various body sites. Cardiovascular disease is the most frequent cause of death among men in the United States (National Center for Health Statistics, 1985). Cancer is the second most frequent

cause of death, accounting for one in three deaths (American Cancer Society, 1985).

In 1982, the Committee on Diet, Nutrition and Cancer, National Research Council, concluded that of all dietary components studied, the combined epidemiological and experimental evidence was most suggestive of a causal relationship between dietary fat intake and incidence of cancers of the colon and breast (Committee on Diet, Nutrition and Cancer, National Research Council, 1982). Similar but less consistent correlations have been reported with cancers of the prostate, ovary and endometrium (Armstrong and Doll, 1975).

Schenkler (1976) examined the relationship between diet and longevity in 28 elderly women. As daily intake of fat increased by one gram, lifespan decreased by 44 days ($r = -0.27$). When fat intake was expressed as percent of calories, the negative correlation with lifespan became stronger ($r = -0.35$). No other dietary components correlated significantly with life span.

In 1981, Shekelle et al. reported the results of a 20-year follow-up study of diet, serum cholesterol and death from coronary heart disease in 1900 men aged 40-55 years at the start of the survey in 1957. Scores summarizing each participant's intake of energy, cholesterol, saturated and unsaturated fat were calculated. Using logistic regression, positive associations were found between diet score and 19-year risk

of death from coronary heart disease ($p<0.01$). This finding persisted after adjustments for change in BMI and smoking habits. However these dietary variables (kilocalories, cholesterol, saturated and unsaturated fat), were not related significantly to risk of death from all types of cancer grouped together, or from all other causes of death grouped together.

In an analysis of dietary information from the Seven Countries study, Keys et al. (1981) found that both the total death rate from all causes, and coronary heart disease death rate were not related to percent kilocalories as fat in the diet. The study covered 12,763 men in 16 cohorts from seven countries. Dietary data were collected by a variety of means from 24-hour recall questionnaires to seven-day weighed intakes. Although mortality was not related to relative weight, physical activity or total fat content of the diet - blood pressure, serum cholesterol and percent kilocalories from saturated fat were significant predictors of all cause mortality and coronary deaths. Percent kilocalories from saturated fat had a moderately strong positive correlation with mortality from all causes ($r = 0.47$), and a strong positive correlation with coronary heart disease mortality ($r = 0.84$). Significance levels were not reported.

In 1983, Sidney and Farquahar reported international per-capita nutrient intake and age-adjusted total cancer mortality rates in 20 countries. Total

calorie intake was correlated positively with cancer mortality ($r = 0.66$, $p<0.01$). Total fat intake also correlated with cancer mortality ($r = 0.68$, $p<0.01$), as did percent of kilocalories from fat ($r = 0.67$, $p<0.01$).

In 1986, however, Heilbrun, Hankin, Nomura and Stemmerman reported the original fat intake of 99 men who subsequently developed cancer of the colon during 14 years of follow-up. This was compared to the original fat intake of 378 men who remained free of any cancer. Mean fat intake was lower in the men who subsequently developed colon cancer ($p = 0.05$). Differences in total energy intake were not reported although BMI was found to predict the development of cancer in the same population (Nomura, Heilbrun and Stemmerman, 1985).

Level of Physical Activity and Mortality

Many early studies on the effect of athletic participation on mortality and longevity failed to compare college athletes with a control group of college graduates. As early as 1926, Greenway and Hiscock observed that college graduates had a higher life expectancy than non-graduates. This finding emphasized the importance of selecting valid controls for college athletes, and of avoiding the use of national statistics for comparison.

In 1954, Rook found no difference between the survival rates and average age of death of honors graduates, college athletes and a random sample of students

from the 1860-1900 Cambridge University classes. Seven-year, follow-up data of the 1952 Michigan State survey, reported by Montoye, Van Huss and Nevai (1962), indicated that there was no difference in the longevity or cause of death, excluding violent deaths, between former college athletes and their controls. Mean age of death for athletes was 62 years, compared to 64 years for non-athletes. This difference was not statistically different at an alpha of 0.05.

It might be expected that participation in college athletics would have a minor influence on health parameters as compared to habitual, long-term activity levels from graduation onwards. In 1984, Paffenbarger, Hyde, Wing and Steinmetz reported that personal athleticism altered trends in lifestyle and coronary heart disease. Analysis of 572 first heart attacks among 16,936 Harvard alumni between 1962 and 1972, and 1,143 total deaths between 1962 and 1978, showed that habitual post-college exercise, but not sports participation in college, predicted low coronary heart disease risk. Sedentary students who became active alumni acquired low risk. Exercise benefit was independent of contrary lifestyle variables such as obesity or cigarette smoking. Total mortality was related inversely to levels of physical activity ($p<.001$). Further analyses of these data, reported by Paffenbarger et al. in 1986, confirmed this trend. Death rates declined steadily as energy expended in

physical activity increased from 500 to 3500 kilocalories/week (p of the trend <0.0001).

In a longitudinal study of 2,622 female former athletic alumnae and 2,776 female non-athletes aged 21-70 years, Frisch et al. (1985) reported a significantly lower relative risk of developing cancer of the breast and reproductive system in former athletes compared to non-athletes. The relative risk for cancer of the reproductive system was 2.53 (95% Confidence Interval 1.17,5.47), and the relative risk of breast cancer 1.86 (95% Confidence Interval 1.00,3.47). The authors concluded that long-term athletic training might lower the risk of breast cancer and cancers of the reproductive system. Death rates from cancers of these sites were not reported. It is not clear whether site specific cancers are more common in male athletes than controls.

Olson, Montoye, Sprague, Stephens and Van Huss (1978) reported no significant differences in causes of death between male athletes and non-athletes after 23 years of follow-up in the Michigan State longevity study. However at the present stage of analysis it is impossible to ascertain the incidence of disease in those subjects who did not die. It is not possible, therefore, to comment on the differences in disease incidence between male athletes and controls, only on numbers and causes of death.

STATEMENT OF THE PROBLEM.

From the literature reviewed it is apparent that although widely cited as major contributors to some of the main causes of morbidity, there is a lack of unequivocal evidence that diet and other lifestyle factors are significant determinants of overall life expectancy. The weaknesses of studies to date may be summarized in the following points:

1) Some study populations have been poorly defined preventing disaggregation into subgroups which might have results significantly different to the results obtained for the sample overall. Examples of such disaggregation are by age, race, socio-economic status and BMI. A significant association between the dependent and independent variables in one subgroup might be masked by an opposite association in another group. The unmasking of different weight mortality relationships in smokers and non-smokers in the Framingham study illustrate this point (Sorlie et al., 1980; Garrison et al., 1983).

2) Conversely, other studies have examined populations with unique characteristics making extrapolation of results to the general population invalid. An example was the Manitoba study in which U.S. and Canadian pilots were selected for the study population (Rabkin et al., 1978).

3) Although in many studies the study populations have been large, usually the length of follow-up has not been long. The results have been based on relatively few deaths. An example was the Chicago Peoples Gas Study, which included a sample size of 1233, but based mortality data on only 246 deaths (Dyer et al., 1975).

4) There is no concensus on which sets of variables form an optimal predictive model for mortality. The variety of variables studied vary from study to study. A variable that is a significant predictor of mortality in one study might not be significant in a more comprehensive model. An example is the different conclusions that are drawn from one data set when cigarette smoking is or is not included in the analysis (Sorlie et al., 1980; Garrison et al., 1983).

5) Many studies used normative data from outside the study population, introducing a possible source of error in evaluation of results. Nationally generated statistics such as life expectancy might not reflect accurately what would be normative in selected samples of the same population. This is particularly true when subjects were not recruited into the study randomly, but were selected on the basis of characteristics such as age, sex and geographical location. More extreme selection criteria such as occupation make it increasingly unlikely that the study population will match the general population from which the normative data were generated. An example

is the selection of U.S. and Canadian pilots as a study population (Rabkin et al., 1978).

The present study overcomes many of the problems described above, and will therefore make a significant contribution to our knowledge of the role of diet and related lifestyle variables to mortality. More specifically this study has the following advantages:

1) The study group is well defined and homogeneous, yet pertains to a large population (white males from a nonmetropolitan area). In 1970 the total adult white male population of the U.S. was 86,720,987. Of these 24,510,744 or 28.3% were living in rural areas. In 1970 26.3% of the adult white male population completed a college education (U.S. Bureau of the Census, 1980). There is no information on differential levels of education between rural and urban areas. Assuming that 26.3% of adult rural males are college graduates, a total of 6,446,326 males fall into the classification of rural white graduates. This represents 7.5% of the total adult white male population in the U.S.

2) The length of the follow-up has been unusually long. The group has been followed for a total of 35 years to date. Further follow-up is planned.

3) As a consequence of the above two points, the total mortality rate in the sample has been high. By combining expected years of life for those still alive with age at death for those deceased, it is possible to use data

from the entire sample to create an independent variable "years of survival" for each subject. This, together with the homogeneity of the sample overcomes the drawback of the relatively small sample size in other studies.

4) Average survival will be derived from mortality data from within the sample, avoiding possible error by comparison with normative data from an incompatible population.

5) Information on a wide range of health and lifestyle variables has been collected longitudinally. This allows many confounders to be examined and controlled for when examining the complex relationships between lifestyle, morbidity, mortality and survival. Only parts of the total data available will be reported here.

6) Dietary data has been collected consistently and in two forms, 24 hour recall and food frequency questionnaire, allowing cross validation during analysis.

In summary, the value of this study lies in the extent and length of the longitudinal data, allowing analyses of the relationships between lifestyle variables and mortality in a well defined population of men.

THE HYPOTHESES.

Data will be used to address the following null hypotheses.

There is no difference in average years of survival, body mass index, total energy intake, percent kilocalories from fat, total fat intake, smoking habits and aerobic activity between male, former college athletes and their controls.

Body mass index, total energy intake, percent kilocalories from fat, total fat intake, smoking habits, participation in college athletics and levels of aerobic activity are not predictive of average years of survival in college men.

METHODS.

Background to the study.

The original impetus for this investigation was a national Phi Epsilon Kappa study of the longevity and morbidity of college athletes that was begun in 1950. Although never completed nationally, the Michigan State University portion of this survey was completed, and the results comparing the life expectancy and cause of death in male athletes and non-athletes were reported by Montoye, Van Huss, Olson, Pierson and Hudec (1957).

In 1952, addresses were obtained for 1,129 varsity letter winners who had participated in Michigan State athletics before 1938. A stratified, random sampling technique was used to select a non-athlete control from the student directory for each athlete in the study. The control attended Michigan State in the same year and class as the paired athlete. Athletes and non-athlete controls were therefore age matched. Mean age difference between athletes and controls was 0.05 years (Montoye et al., 1959).

Mailed questionnaires were sent to each athlete and control. Of these, 625 athletes and 557 non-athletes returned the information requested. These subjects formed the basis of the longitudinal study. All living respondents were mailed repeat questionnaires in 1960, 1967, 1975 and 1985. It is from these returns that the

sample for the present study was drawn.

The sample.

The present study comprises approximately half of the records which were collected from 1967-1985. The subjects selected were former footballers, former track athletes and their respective controls. This resulted in a sample of 338 subjects, 213 of whom were former athletes and 125 of whom were controls. The difference in the numbers of athletes and controls is as a result of a decreased response rate in the control group (Montoye, 1967). Although age matched at the start of the study, each former athlete was not paired with his original control in this sample. This was because of deaths and non-response in both groups. Footballers and track athletes were selected as they represented two well defined groups of athletes, with different body types typically associated with the two different sports. The remaining athletes not investigated in this study were letter winners in a wide variety of sports such as swimming, hockey, baseball and cross country running.

The questionnaires.

Questionnaires were sent to subjects in 1952, 1960, 1967, 1976 and 1985. Information was requested on a wide range of health and lifestyle variables, including height, weight, history of illness, physical activity,

smoking habits, drinking habits and family history (Appendix 1). From 1968 onwards, dietary information was obtained in two forms: a 24-hour recall and a food frequency questionnaire based on thirty foods and food groups. The format for collection of the dietary information was recommended by faculty from the department of Food Science and Human Nutrition under the direction of Dr. Olaf Mickelsen.

Collection of the data.

For each of the surveys returned in 1967, 1976 and 1985 the following data were extracted for use in the present study:

1) Name, date of birth. Subjects were assigned an identification number which was used in all analyses to ensure anonymity.
2) Date the questionnaire was completed.
3) Year of death, if subject was deceased.
4) Height.
5) Weight.
6) Dietary recall.
7) Food frequency questionnaire.
8) Consumption of alcoholic beverages.
9) Level of physical activity.
10) Smoking habits in 1952.

Information on all dietary variables, height and weight and alcohol intake was collected from the original survey returns which are archived in Jenison Fieldhouse, Michigan State University. Level of physical activity and smoking habits in 1952 were taken from a database of results which have been coded previously. A more detailed explanation of the collection of each variable is given below.

Height and weight.

Self-reported height and weight were collected at each survey. Reports were made in feet and inches for height, and pounds for weight. These were converted to metric equivalents before being recorded. Body mass index (BMI) or $Wt(kg)/Ht(m)^2$ was calculated for each subject in the years they responded to the survey.

Dietary variables.

Subjects were asked to complete one open format 24-hour recall and one food frequency questionnaire in each of the last three surveys (1967, 1975, and 1985). Instructions and a guide to portion sizes was provided in the questionnaire (Appendix 1). A total of 667 24-hour recalls were analyzed for the present study, using the Michigan State University Nutrient Database which is one of the largest in the country and contains nutrient analyses for over 5500 foods (Leveille, Zabik and Morgan, 1983).

Computer commands for the program are shown in Appendix 3. All of the dietary information was coded under the supervision of the author, allowing standardization of common portion sizes, coding technique, and constancy of judgment error.

The food frequency questionnaires were used for clarification of 24-hour recalls. The most common examples of this clarification were in ascertaining whether sugar was taken in tea and coffee or on breakfast cereal. If these items were not recorded on the 24-hour recall as having sugar added, the response to the items on the food frequency questionnaire "Sugar: on cereal, Daily/Weekly/Never", and "Sugar: in coffee, tea, etcetera, Daily/Weekly/Never", were examined and the appropriate adjustments made to the recall. Otherwise, results from the food frequency questionnaires are not reported in this study. Analysis was made for over 80 nutrients, from which the following were extracted for use in the present study:

1) Percent kilocalories from protein.
2) Percent kilocalories from fat.
3) Percent kilocalories from carbohydrate.
4) Percent kilocalories from alcohol.
5) Total kilocalories.
6) Total fat in grams.

Alcohol intake.

Questions on alcohol intake were asked separate to the dietary recall and food frequency questionnaire (Appendix 1). Responses were reformulated in terms of equivalent daily intake of beer, wine or liquor and added to the 24-hour recall. If alcoholic beverages were already recorded on the recall, no further alcoholic beverages were added. Consumption of alcoholic beverages "less than once a week" was interpreted as one 10oz bottle of beer a week, one 6oz glass of medium white table wine a week or one shot of 90% proof whiskey a week for the the categories beer, wine and liquor, respectively. These were selected as they were the alcoholic beverages recorded most frequently on the 24-hour recalls.

Physical activity.

Physical activity was expressed as kilocalories of aerobic activity per week, as calculated by Quinn (1987). Calculations were made for the 1975 and 1985 surveys only. Information collected from the 1967 questionnaire was considered as lacking sufficient detail to allow for the calculation of activity levels.

Quinn adapted the work of Bannister and Brown (1968), and Howley and Glover (1976) in order to arrive at a figure of aerobic activity per week. A table was formed listing the caloric expenditure in kilocalories/min/lb body weight for each of the activities listed on the 1975 and

1985 questionnaires. Aerobic activities were considered to be those which "utilized the major muscle groups and were performed at an intensity considered appropriate for conditioning" (Quinn, 1987). They were cycling, jogging, lawn mowing (power or hand), golf (walking), walking, rowing, skating, cross country skiing, snow shoeing, dancing, swimming and calisthenics (Appendix 2).

Caloric expenditure was calculated by multiplying the subjects weight in pounds by the number of minutes each activity was performed per month, as reported on the questionnaire (Appendix 1). This figure was multiplied by the caloric expenditure associated with that activity to arrive at caloric expenditure per month. This was repeated for each month, and a mean monthly caloric expenditure calculated. This figure was divided by 4.2 (4.2 weeks/month) to arrive at weekly aerobic activity in kilocalories.

Smoking habits.

Cigarette smoking as of 1952 was recorded in one of four categories: No cigarette use, light smoker (less than 20 cigarettes per day), moderate smoker (20 to 40 cigarettes per day), and heavy smoker (more than 40 cigarettes per day). Smoking habits from subsequent surveys were not coded for computer analysis at the time of this study. Statements about smoking behavior can only be related to whether a subject was a smoker or non-smoker at

the beginning of the survey in 1952.

Years of survival.

The independent variable, average years of survival, was calculated for each year surveyed. The variable represents the mean number of years survived by the sample at each survey. For each subject, the value for the variable was either:

1) Age at death if the subject had died,
2) Age in the year of the survey if the subject was still alive, or
3) The age of the subject as of 1980 if the subject was lost to follow-up.

By calculating years of survival, a value for the independent variable was available for each subject. If age at death alone had been used as an independent variable, inferences about the influence of the dependent variables on survival would have been restricted to those subjects who died prior to 1985. This would have reduced the sample size by approximately 50%.

Management of the data.

Dietary analysis was performed on the mainframe computer at Michigan State University and results transferred to magnetic tape for storage. Once calculated, all variables used in the present study were copied from magnetic tape to the mainframe computer and assembled into

one data file. This was then downloaded to a floppy disk and edited using a word processor. Age (year of birth minus year of questionnaire), and body mass index (weight(kg)/height(m)^2) were calculated using a spreadsheet. Edited files were transformed to ASCII format for subsequent statistical analysis on both the mainframe and microcomputer.

Validation of data collection methods.

Dietary variables.

Although 24-hour recalls of food intake do not provide accurate estimates of the usual intakes of individuals, they have been found to be valid for determining the intake of groups (Madden, Goodman and Guthrie, 1978). The larger the sample, the more reliable the estimate, and the smaller the standard deviation for any particular nutrient (Beaton et al., 1979). Validation of the use of 24-hour recalls in this study was made by comparing the dietary intakes of the sample in the present study with the results of two national surveys. The numbers of subjects in the present study were not of the scale seen in national surveys, and consequently standard deviations for some variables are high.

In all three surveys dietary intakes were similar to those found in both the National Health and Nutrition Examination Survey, NHANES II (National Center

for Health Statistics, 1983) and the Nationwide Food Consumption Survey of 1977-78, NFCS (U.S. Department of Agriculture, 1983). It is pertinent to compare the data from NHANES II with those from the present study, because methods of collecting the dietary information were comparable (24-hour recall and food frequency questionnaire), although the sampling techniques were different. Comparison of the present study with NHANES II is shown in Table 2. NHANES II data were collected for men up to the age of 74 years. In the USDA Nationwide Food Consumption Survey, three day records were used to collect dietary information. Data were reported for men aged 75 years and over. Comparison with the National Food Consumption Survey is shown in Table 3. Because of the comparability of these data, the author is confident that the collection of dietary information in the present study was as accurate as that in the two nationwide surveys cited. This is true despite the fact that both of the nationwide surveys collected data through personal interview, whereas in the present study data were self-reported.

Body mass index.

Body mass index (BMI) was the index of adiposity selected for use in the present study. BMI has a high correlation ($r = 0.666$) with the amount of body fat as estimated from body density, particularly when age is taken

Table 2. Comparison of dietary intakes of males in NHANES II with those in the present study.

	NHANES II 1977-1980		MICHIGAN STATE STUDY 1967	1975	1985
AGE YRS	55-64 n=1227	65-74 n=1199	64.0 n=336	68.9 n=213	75.7 n=115
Kcals/ day	2071	1829	2143	1934	1779
% Kcals protein	16.2	16.0	15.8	15.6	16.1
% Kcals fat	39.2	37.9	41.6	41.0	38.0
% Kcals carb	43.8	44.6	40.6	41.0	43.5
Fat g/day	86.0	75.0	98.6	86.2	72.2

Table 3. Comparison of dietary intakes of males in the National Food Consumption Survey 1977-78 with those in the present study

	NFCS 1977-1978			MICHIGAN STATE SURVEY 1967	1975	1985
AGE YRS	51-64 n=2161	65-74 n=1049	>74 n=465	64.0 n=336	68.9 n=213	75.7 n=115
Kcals/ day	2158	1913	1866	2143	1934	1779
% Kcals protein	16.7	14.6	16.1	15.8	15.6	16.1
% Kcals fat	42.8	41.0	41.2	41.6	40.5	38.0
% Kcals carb	39.2	42.2	42.8	40.6	41.0	43.5
Fat g/day	102.6	87.1	85.4	98.6	86.2	72.2

into consideration (Norgan and Ferro-Luzzi, 1982). It has a low correlation (r = 0.062) with height, and is generally accepted as the most satisfactory index of adiposity based on weight and height alone (Keys, Fidanzo, Karvonen, Kimura and Taylor, 1972). The recommendation from the 1982 National Health and Nutrition Examination Survey workshop on body weight, health and longevity was to report weight as body mass index in order to facilitate comparability of data ("Body weight", 1985).

When compared to national figures for BMI of white males aged 55-74 years, the mean BMI of the total sample in 1967, 1975 and 1985 fell on the 50th percentile (National Center for Health Statistics, 1983). Comparisons with NCHS data are shown in Table 4.

In all three surveys of the Michigan State study, the median value for BMI (50th centile), was identical or close to the mean value. This suggests that BMI was normally distributed in the sample as it is in the general population. In the MSU study BMI was calculated from self-reported height and weight. Although the level of accuracy in reporting height and weight has been found to vary from study to study, it is generally agreed that the degree of inaccuracy involved in the self report of these measures is not sufficient to significantly bias results (Palta, Prineas, Berman and Hannan, 1982; Stewart, Jackson, Ford and Beaglehole, 1987; Stunkard and Albaum, 1981). It should be noted, however, that in none of the

Table 4. Comparison of BMI for white males in a national sample 1977-80 with those in the present study.

	NCHS 1977-1980		MICHIGAN STATE STUDY 1967	1975	1985
AGE (YRS)	55-64 n=1086	65-74 n=1045	64.0 n=336	68.9 n=213	75.7 n=115
Mean BMI	26.1	25.6	25.7	25.8	25.4
50th centile	25.8	25.5	25.5	25.8	25.1

studies cited were the subjects older than 60 years. The mean age in the 1967 survey of the Michigan State sample was 64 years. The close agreement of national mean and median figures for BMI with those in the present study suggests that the method of data collection used in the Michigan State study was as accurate as those employed by the NCHS.

Physical activity.

Information on physical activity levels was obtained in a format based on the Minnesota Leisure Time Physical Activity (LPTA) questionnaire (Taylor, Jacobs and Schucker, 1978). This instrument has been used extensively in clinical and cardiovascular surveys. Folsom, Jacobs, Caspersen, Gomez-Martin and Knudsen (1986) assessed the test-retest reliability of the Minnesota LTPA questionnaire at five-week intervals in 140 adults from a general population sample. They reported a Spearman rank

correlation coefficient between the test and retest of r = 0.88 ($p<0.001$). The Minnesota LPTA questionnaire has also been validated against duration of treadmill exercise (Leon, Jacobs, and DeBacker, 1981). However it is important to note that in the validations cited, total leisure time activity was calculated. In the present study, only aerobic leisure time activity was calculated; anaerobic leisure time activity was not. The LTPA questionnaire has not been validated for aerobic activity alone.

Statistical analysis.

Hypothesis One.

There is no difference in average years of survival, body mass index, total energy intake, percent kilocalories from fat, total fat intake, smoking habits and aerobic activity between male, former college athletes and their controls.

Descriptive statistics were performed on all variables for the years 1967, 1975 and 1985. Within each year the sample was subdivided into former athletes and non-athlete controls. Differences between athletes and non-athletes for each variable were tested using the Student's

t-test. A probability level of .05 or less was defined as statistically significant.

To investigate the possible effect of age on the variables measured, Pearson product-moment correlations were calculated between age, dietary variables and BMI for each of the years surveyed. To investigate the possible effect of cigarette smoking as a confounder to the variables measured, the sample was divided into those who smoked in 1952, and those who did not smoke in 1952. Descriptive statistics were performed on these groups, and differences tested for with t-tests as above. Smokers and non-smokers were further subdivided into athletes and controls and descriptive statistics and tests of significance were repeated.

Hypothesis two.

> Body mass index, total energy intake, percent kilocalories from fat, total fat intake, smoking habits, participation in college athletics and levels of physical activity are not predictive of years of survival in college men.

This hypothesis was tested by the Cox Proportional Hazards Regression Model (Steeland, Beaumont and Horning, 1986, Biomedical Computer Programs, 1982) using the mainframe computer at the University of Michigan,

Ann Arbor. This model presumes that death rates may be modelled as log-linear functions of covariates which explain differences in survival. These covariates may be fixed (such as sex), or time dependent (such as years of smoking). The model estimates regression coefficients that relate the effect of each covariable to the survival function. Step-wise regression using the Cox model was used to identify which covariables were significant predictors of years of survival. The Cox model is the regression model of choice when following a sample over time (Steeland, Beaumont and Horning, 1986). Unlike logistic regression, the Cox model allows the incorporation of variables that change over time. It also allows for the simultaneous adjustment for several confounders. These properties make the Cox model ideal when longitudinal data is available on a "hazard" (death), and time dependent covariables (diet, smoking, activity). The assumption inherent in the model is that of proportional hazards. That is, it is assumed that the relative risk of death remains constant over time.

For exploratory purposes, the entire sample was subdivided into those subjects who lived throughout the entire length of the study, those who died between the 1967 and 1975 survey, and those who died between the 1975 and 1985 survey. Comparisons were made between the group who remained alive and the groups who died after each survey in order to determine if significant differences existed

between those subjects remaining alive and those dying. This was in contrast to the Cox model, in which average years of survival for the entire group was used as the dependent variable.

RESULTS AND DISCUSSION.

Results are presented by hypothesis. A discussion of the results follows each hypothesis. Under hypothesis one, smoking habits in 1952 and age are examined as potential confounders to the comparisons between former athletes and controls. In addition to those variables specified in the hypotheses, percent kilocalories from protein, carbohydrate and alcohol are presented for completeness. Similarly, height in meters for each of the years surveyed, weight in kilograms for each of the years surveyed and BMI at graduation for the subjects in each year surveyed are presented in addition to BMI at the time of each survey.

Hypothesis one: Results.

Comparison of dietary variables, BMI and aerobic activity of former athletes and controls.

Detailed results for the breakdown of the sample by year of survey and by former athlete and control are shown in Table 5. There were no significant differences between athletes and controls for any of the variables measured in 1967. Athletes were heavier than controls, but this was not statistically significant. Similarly the mean BMI of athletes at graduation was slightly but not significantly higher than controls.

There were no significant differences between athletes and controls with respect to any of the variables measured in 1975. Athletes expended more kilocalories/week as aerobic activity than controls, but the difference was not statistically significant. The large standard deviations seen in aerobic activity are a result of the wide range of values reported; from 0 to 7839 kilocalories per week. In 1975 the athlete respondents were still slightly, but not significantly, heavier than controls.

In the 1985 survey, athletes consumed significantly more kilocalories/day than controls. The slight difference in aerobic activity between former athletes and controls seen in 1975 was not seen in 1985. As in 1967 and 1975, former athletes were heavier than controls, but this difference was not statistically significant.

Table 5. Comparison of dietary variables, BMI and aerobic activity of athletes and controls in each year surveyed.

		YEAR OF QUESTIONNAIRE					
		1967		1975		1985	
VARIABLE		ATH N=211	CON N=125	ATH N=147	CON N=66	ATH N=80	CON N=35
Age/ yrs	Mean	62.8	65.9	68.5	69.8	75.1	77.1
	S.D	9.9	10.9	7.7	8.8	5.3	7.1
Kcals/ day	Mean	2149	2133	1908	1992	1850*	1618*
	S.D	856	617	923	708	802	660
% Kcals protein	Mean	15.9	15.6	16.0	14.8	16.7	14.8
	S.D	4.4	4.2	4.7	3.6	5.5	4.2
% Kcals fat	Mean	42.0	41.1	40.0	41.7	36.8	40.9
	S.D	11.4	8.9	11.7	10.0	9.5	11.9
% Kcals carb	Mean	40.0	41.6	41.3	40.3	44.0	42.3
	S.D	13.4	11.5	12.9	11.2	12.4	14.1
% Kcals alcohol	Mean	3.4	2.9	4.3	4.5	4.0	3.8
	S.D	7.3	6.2	9.6	7.4	7.7	8.8
Fat g/day	Mean	98.4	98.9	83.8	91.6	73.7	68.6
	S.D	46.8	38.8	45.0	39.2	37.6	27.5
Activity kcals/wk	Mean	N.A	N.A	1625	1327	1667	1600
	S.D			1602	1589	1581	1636
Years survived	Mean	75.4	76.6	76.9	77.6	75.0	76.6
	S.D	9.8	10.4	7.4	8.3	5.5	7.1
Height (m)	Mean	1.78	1.76	1.78	1.77	1.79	1.77
	S.D	0.06	0.06	0.06	0.06	0.06	0.06
Weight (kg)	Mean	82.9	77.6	83.8	78.5	82.7	77.5
	S.D	11.1	8.6	11.0	8.1	11.6	11.3
BMI Graduation	Mean	23.8	22.3	24.1	22.4	23.4	22.6
	S.D	2.6	2.2	2.7	2.1	2.5	2.2
BMI	Mean	26.0	25.0	26.1	25.1	25.7	24.8
	S.D	2.7	2.6	2.7	2.3	2.7	3.5

* significant difference between values for athletes and controls, 1985. $p<0.05$ (t-test).

Comparison of smoking habits between former athletes and controls.

The numbers of athletes and controls who were smokers in 1952 at each year surveyed are shown in Table 6. Categories of smoking are described in the methods section. The percentage of smokers and non-smokers in 1952 by athlete and control at each of the years surveyed is shown in Table 7.

A higher percentage of former athletes than controls were smokers in 1952. For former athletes the proportions of respondents who were smokers in 1952 remained similar in each year surveyed, although there was a slight decline in the proportion of respondents who were smokers in 1952 surviving in 1985. For controls, there was a larger decrease than for former athletes in the proportion of subjects who were smokers in 1952 who survived to 1985. This would suggest that more subjects who were non-smokers in 1952 survived to 1985 than subjects who were smokers in 1952. However the difference in proportions of respondents who were smokers in 1952 in the years surveyed were not statistically significant. In order to illustrate the distribution of smokers in 1952 among the three categories of cigarette use, the percent of smokers in each category by athlete and control for each year surveyed is shown in Table 8. Numbers are percentages of all smokers in 1952. There was no significant difference between the percentage of respondents who were

Table 6. Categorization of respondents to each survey by smoking behavior in 1952.

	YEAR OF QUESTIONNAIRE					
	1967		1975		1985	
SMOKING CATEGORY*	ATH	CON	ATH	CON	ATH	CON
0	58	54	38	29	25	19
1	30	17	27	8	11	3
2	76	30	50	12	25	5
3	37	23	31	9	19	5
Total Smokers	143	70	108	29	55	13
Total**	201	124	146	58	80	32

* 0 = Non-smoker, 1 = <20 cigarettes per day, 2 = 20-40 cigarettes per day, 3 = >40 cigarettes per day.

** Discrepancies between these totals and the total numbers of athletes and controls in each year are due to missing data on smoking habits.

Table 7. Percentages of smokers and non-smokers in 1952 by athlete and control for each year surveyed.

	YEAR OF QUESTIONNAIRE					
	1967		1975		1985	
SMOKING CATEGORY	ATH	CON	ATH	CON	ATH	CON
% Smoker	71.1	56.5	74.0	50.0	68.7	40.6
% Non-Smoker	28.9	43.5	26.0	50.0	31.3	59.4

smokers in 1952 in each of the three categories for athletes and controls for any of the years surveyed. However, it appears that there were more former athletes than controls who were moderate smokers in 1952 in all three years surveyed.

Table 8. Percent of respondents to each survey who smoked in 1952 in each category of smoking behavior.

	YEAR OF QUESTIONNAIRE					
	1967		1975		1985	
SMOKING CATEGORY*	ATH n=201	CON n=124	ATH n=146	CON n=58	ATH n=80	CON n=32
% in 1	21.0	24.3	25.0	27.6	20.0	23.1
% in 2	53.1	42.9	46.3	41.4	45.5	38.5
% in 3	25.9	32.8	28.7	31.0	34.5	38.5

*1 = <20 cigarettes per day, 2 = 20-40 cigarettes per day, 3 = >40 cigarettes per day.

Age as a confounder to dietary variables, BMI and aerobic activity.

In the examination of differences between former athletes and controls the confounding effect of age on the variables measured was assessed. Table 9 shows the Pearson product-moment correlations between age and dietary variables, physical activity and BMI for each year surveyed.

Table 9. Pearson product-moment correlations (r) of dietary variables, physical activity and BMI with age for each year surveyed.

	YEAR OF QUESTIONNAIRE		
VARIABLE	1967 n=336	1975 n=213	1985 n=115
% Kcals protein	.05	-.04	-.07
% Kcals fat	-.16	.07	-.06
% Kcals carb	.20**	.08	.19
% Kcals alcohol	-.11	-.15	-.17
Kcals/ day	.07	-.10	-.10
Fat g/day	-.01	.07	-.15
Activity Kcals/wk	N.A	-.30**	.01
BMI	-.22**	-.15	-.37**

* N/A: not available.
** significant ($p<.05$).

There were no moderate or strong correlations between age and any of the variables measured in 1967, 1975 or 1985. There was a weak negative correlation ($r = -.30$) between age and aerobic activity in 1975, and between age and BMI in 1985 ($r = -.37$).

Smoking as a confounder to dietary variables, BMI and aerobic activity.

Comparison of all variables measured in the total sample by smoker in 1952 and non-smoker in 1952 are shown in Table 10. No significant differences were seen between smokers and non-smokers for any of the variables measured in any of the years surveyed, with the exception of aerobic activity in 1975. Those who were smokers in 1952 expended significantly more kilocalories per week as aerobic activity in 1975 than those who were non-smokers in 1952. Participation in college athletics was then included as a variable in the analysis of the difference in aerobic activity between those respondents who smoked in 1952 and those respondents who did not smoke in 1952. The results are shown in Table 11. When former athletes were considered, there were no significant differences with respect to any of the variables measured between those who smoked in 1952 and those who did not. When controls were considered, there was a significant difference between those who smoked in 1952 and those who did not. Those who smoked in 1952 were more aerobically active than non-

Table 10. Comparison of dietary variables, BMI and aerobic activity of those who smoked in 1952 and those who did not smoke in 1952 by year of questionnaire.

		YEAR OF QUESTIONNAIRE					
		1967		1975		1985	
VARIABLE		S* N=223	NON N=112	S N=145	NON N=68	S N=70	NON N=45
Age/ yrs	Mean	63.2	65.4	68.9	69.1	74.9	77.1
	S.D	9.8	11.3	8.2	7.8	5.5	6.4
Kcals/ day	Mean	2164	2102	1879	2051	1729	1857
	S.D	817	685	743	1068	802	710
% Kcals protein	Mean	15.9	15.5	15.7	15.6	16.5	15.4
	S.D	4.5	4.1	4.5	4.4	5.3	5.0
% Kcals fat	Mean	39.1	41.3	39.9	42.0	38.5	37.3
	S.D	13.3	9.4	11.2	11.3	10.1	11.0
% Kcals carb	Mean	39.1	43.6	40.4	42.3	41.2	47.1
	S.D	13.3	10.9	12.6	11.9	12.1	13.4
% Kcals alcohol	Mean	4.3	1.0	5.5	1.8	5.1	2.1
	S.D	7.9	3.2	10.2	4.7	9.5	4.5
Fat g/day	Mean	99.9	96.1	83.8	91.3	71.8	72.8
	S.D	47.0	37.1	40.0	49.8	38.4	28.6
Activity kcals/wk	Mean	N.A	N.A	1629**	1339**	1716	1541
	S.D			1702	1367	1746	1345
Years survived	Mean	75.0	77.5	76.7	77.8	74.6	77.0
	S.D	10.3	9.2	7.8	7.3	5.8	6.3
Height (m)	Mean	1.78	1.76	1.79	1.76	1.79	1.78
	S.D	0.06	0.06	0.06	0.06	0.05	0.06
Weight (kg)	Mean	81.7	78.9	82.9	80.7	82.8	78.4
	S.D	10.3	10.7	10.1	11.1	9.1	14.4
BMI Graduation	Mean	23.5	22.8	23.9	22.9	23.7	22.4
	S.D	2.6	2.6	2.6	2.6	2.4	2.3
BMI	Mean	25.7	25.5	25.9	25.5	25.9	24.7
	S.D	2.6	3.0	2.5	2.9	2.5	3.5

* S=smoker in 1952, Non=non-smoker in 1952.
** significant difference between values for smokers and non-smokers, 1975, $p<0.05$ (t-test).

Table 11. Comparison of aerobic activity (Kcals/week) in 1975 between athletes, controls, those who smoked in 1952 and those who did not smoke in 1952.

	ATHLETE	CONTROL	SIG
Smoker 1952	1651 ±1697 (n=108)	1563 ±1744 (n=29)	n.s
Non-Smoker 1952	1557 ±1327 (n=38)	1074 ±1391 (n=29)	p<.05
SIG	n.s	p<.05	

smokers. These differences were not apparent in 1985. Athletes who were smokers in 1952, athletes who were not smokers in 1952 and controls who were smokers in 1952 all expended similar amounts of energy per week in aerobic activity in 1975. Only controls who were not smokers in 1952 had a significantly lower aerobic activity level in 1975.

Hypothesis one: Summary.

There were no significant differences between former athletes and controls for any of the variables measured in 1967 or 1975. In 1985, former athletes consumed significantly more kilocalories per day than controls. More former athletes than controls were smokers in 1952. There were no differences between those who smoked in 1952 and those who did not smoke in 1952 with respect to any of the dietary variables measured or body

mass index for any of the years surveyed. Although the mean age of the sample increased with each subsequent survey, there were no moderate or strong correlations for age with any of the dietary variables measured, body mass index, or aerobic activity.

Hypothesis one: Discussion.

The finding that in 1985 former athletes consumed significantly more kilocalories than controls should be interpreted with care considering the large standard deviations associated with this variable and the small number of controls (35) in the 1985 survey. A difference of 232 kilocalories, although statistically significant, probably has little practical significance for health and longevity. The composition of the diet with respect to protein, fat, carbohydrate and alcohol was the same in the two groups. The difference in energy intake is therefore the result of eating less of the same diet rather than of eating less of one particular macro-nutrient such as fat.

The finding that BMI at graduation was higher in former athletes than controls is in agreement with the findings of Montoye, Van Huss, Olson, Peirson and Hudec (1957), that athletes were heavier than non-athletes in 1952. Although it might be expected that taller and heavier men would be recruited for college sports (particularly football), there was no statistically

significant difference in the heights or weights of former athletes and controls throughout the survey.

Despite the recommendation that BMI be adopted as the adiposity index of choice in reporting results, there are limitations to the interpretation of BMI, particularly when no other anthropometric measurements are available. Although highly correlated with body fat, BMI is not independent of stature. Garn, Leonard and Hawthorne (1986) concluded that BMI as an index of adiposity is confounded by relative sitting height (sitting height/standing height). That is, the correlation of BMI with body fat is reliant on particular proportions of upper and lower body lengths. Although the majority of the population would be expected to fall within a narrow range of relative sitting height, those with unusually short or long legs in relation to their total height would have a lower correlation of BMI to adiposity. Athletes are one group of individuals who are often selected on the basis of physical attributes such as "long legs". Although it is impossible to quantify relative sitting height from the information collected in this study, it remains possibile that in some athletes, BMI was confounded by sitting height, and was not as accurate a measure of adiposity as in controls. Wilson (1986) found that former athletes in the Michigan State study were significantly more mesomorphic and less ectomorphic than non-athletes ($p<.05$). Furthermore, Wilson found that somatotype was a

significant predictor of life expectancy ($p = .001$), with endomorphs surviving fewer years than mesomorphs and ectomorphs. However, differences in somatotype between former athletes and controls cannot be revealed by comparison of BMI alone.

The mean aerobic activity level of former athletes was higher than that of controls, but there was a large variance in energy expended as aerobic activity in both groups and the difference between them was not significant. Quinn (1987) also found in a sample of former athletes and controls drawn from the respondents used from the Michigan State study, higher aerobic leisure time aerobic energy expenditure in former athletes compared to controls. In his sample, the difference was significant ($p < .05$). Increased activity in former athletes might reflect the continuation of patterns of aerobic activity established in school. The historical recall of activity required in the questionnaire might result in a more accurate record for those with an established and regular pattern of exercise as opposed to those who exercise less consistently or in many different ways. There is the possibility that former athletes are more aware of aerobic activity levels and are therefore more accurate and more thorough in recording them.

No consideration of non-aerobic leisure time pursuits was made in this study. Although these activities were not of sufficient length or duration to be aerobic,

they do require energy. Also, leisure time activity alone was measured. In manual jobs, vocational activity might be the major component of energy expenditure. However it is likely that most of the subjects in the present study were either retired or in sedentary jobs. There is no reason to believe that vocational activity is not normally distributed in the sample, and would therefore contribute equally to the energy expenditure of former athletes and controls. The lack of consideration of vocational activity, and the contribution of non-aerobic activity to energy balance make it unlikely that energy balance is described completely by the measurements in this study.

In the 1985 survey the difference between the aerobic activity level of former athletes and controls is smaller than that seen in the 1975 survey. It appears that surviving controls had aerobic activity levels comparable to those of former athletes, although it should be emphasized that the difference in 1975 was not statistically significant. If a difference in the activity levels of former athletes and controls does exist, it is possible that controls increased their aerobic activity level in response to the increased public interest in fitness and exercise which started in the mid 1970s. If this were the case, the figures suggest that former athletes were already exercising aerobically before the "fitness boom", and controls started to exercise after 1975, resulting in no difference between the groups by

1985. It would be interesting to analyze the type of activities undertaken to determine if the increase seen in the control group was accounted for entirely by an increase in calisthenics and jogging. Alternatively (or additionally), the increased public awareness of the importance of exercise may have made the controls more aware of their activity patterns in and more accurate in completing their questionnaires in 1985 than 1975. It is unfortunate that activity levels have not been calculated for the 1967 survey. They would be useful in determining whether the increased activity in controls occured soley in the mid-seventies, or if differences were apparent at an earlier date.

There was no difference in average years of survival between former athletes and controls in this study after 35 years of follow-up. This confirms the findings of Montoye, Van Huss and Nevai (1962) after seven years of follow-up of the same sample, and of Wilson (1986) that participation in college athletics was not a significant predictor of life expectancy. Paffenbarger (1986) also found no relationship between survival and participation in college athletics.

In all surveys, the average number of years survived by both former athletes and controls were greater than the life expectancy for white males in the U.S. and in Michigan in 1984. The difference between this sample and the population of Michigan is particularly significant,

because it eliminates regional differences in life expectancy as a confounder to the comparison with the sample in the present study. One possible explanation for the longer average survival in the present sample when compared to Michigan statistics is that Michigan statistics include data from metropolitan areas such as Detroit. The mean life expectancy in Detroit is lower than that in the rest of the State (Michigan Department of Public Health, 1987). The sample in the present study was predominantly rural. Also, there is evidence to suggest that college graduates have a higher life expectancy than non-graduates (Greenaway and Hiscock, 1926). It is not clear why this should be so, although a high level of education might result in increased knowledge of health risks and their avoidance. Perhaps college graduates attain a higher socio-economic status than non-graduates. Life expectancy increases with increasing income (U.S. Department of Commerce Bureau of the Census, 1978), and socio-economic status (Haan, Kaplan and Camocho, 1987).

The lack of correlation of age with any of the variables measured implies that age is not a confounder to any of the relationships between them. This does not eliminate the possibility of increased innaccuracy of reporting dietary data with increasing age. It would be necessary to conduct detailed weighed intakes on a sub-population of the subjects in order to quantify the discrepancies between reported and actual intake and relate

these discrepancies to age.

The reasons why approximately twice as many former athletes as controls were smokers in 1952 are not clear. The reasons for this are unclear. Montoye, Van Huss, Olson, Peirson and Hudec (1957) suggested that more former athletes smoked as a reaction against the restrictions imposed by training regimes in college. More former athletes were moderate smokers than were controls, and more controls were heavy smokers than were former athletes. There was, however, no significant difference in the level of cigarette use between those former athletes and controls who were smokers. The high percentage of smokers in both former athletes and controls in 1952 might reflect the increased social acceptability of smoking at this time, and the lack of evidence for the associated health hazards.

Although Albanes, Jones, Miccizzi and Mattson, 1987) found that smokers were leaner than non-smokers in the NHANES II, no difference in BMI was found between smokers in 1952 and non-smokers in 1952 in this study. The interaction between aerobic activity and smoking in 1952 found in this study might be responsible, however the finding is difficult to explain. Perhaps the non-smoking controls did not feel exercise was necessary as they did not consider themselves at risk.

An interesting finding that arose from the comparison of the smoking habits of former athletes and

their controls in 1952 was that the percentage of subjects who were smokers in 1952 who survived to 1985 decreased more in the control group than in former athletes. This suggests that in the control group, more of those who were smokers in 1952 than non-smokers in 1952 died. This difference was not apparent in the former athletes. Apart from smoking habits in 1952, participation in athletics in college and level of aerobic activity were the only variables that distinguished former athletes and controls. If more smokers in 1952 in the control group than smokers in 1952 in the former athlete group had died before 1985, athletic participation in college and/or higher levels of aerobic activity might later have been protective against the deleterious effects of smoking. It is possible that any survival advantage gained by increased aerobic activity may be negated by the deleterious effects of smoking, resulting in no significant difference in years of survival between former athletes and controls. However this cannot be concluded without further information on smoking habits prior and subsequent to 1952. Also, the change in proportions of smokers in 1952 and non-smokers in 1952 over the three surveys was not statistically significant.

Hypothesis two: Results

Prediction of survival by the Cox Proportional Hazards Regression Model.

Stepwise regression using the Cox model demonstrated that in the total sample aerobic activity was the only significant predictor of average years of survival of the variables measured. The variables used in the Cox model, together with the significance levels for prediction of average years of survival are shown in Table 12. As a

Table 12. Significance levels of dietary variables, BMI and participation in college athletics for prediction of average years of survival from stepwise regression using the Cox Proportional Hazards regression model.

VARIABLE	P-VALUE
Kcals/day	0.426
% Kcals protein	0.940
% Kcals fat	0.531
% Kcals carb	0.677
Fat g/day	0.373
Alcohol Y/N	0.748
BMI	0.360
Athlete Y/N	0.059
Activity*	0.025
Smoker Y/N	0.551

* significant at p<.05

result of the stepwise procedure, the significance level reported for all variables other than aerobic activity reflect an adjustment to control for differences in aerobic activity between the subjects.

Comparison of the sample by survivors and those dying between surveys.

Descriptive statistics were used for exploratory purposes, to determine if differences existed in any of the variables measured between those subjects who remained alive throughout the three surveys (survivors), those who died between the 1967 and 1975 surveys, and those who died between the 1975 and 1985 surveys. This analysis attempted to describe the dichotomy survived/died rather than the continuous variable years of survival which was used in the Cox model.

Numbers and percentages of those surviving and those dying or lost to follow-up between the surveys are shown in Table 13. The difference in sample size of the survivors between 1967 and 1975 is accounted for by six subjects who did not return 1975 questionnaires, but subsequently returned 1985 questionnaires. There were no statistically significant differences with respect to any of the variables measured between those who died between 1967 and 1975 and those who remained alive throughout all surveys. Similarly, there were no significant differences with respect to any of the variables measured between those

who died between 1975 and 1985 and who lived throughout the surveys. Those subjects who remained alive throughout the three surveys were younger than those who died. However these differences were not statistically significant.

Table 13. Numbers and percentages of subjects surviving to 1985, dying between surveys and lost to follow-up by former athlete and control.

	YEAR OF QUESTIONNAIRE			
	1967		1975	
	ATHLETE n=211	CONTROL n=125	ATHLETE n=147	CONTROL n=66
Survived to 1985	75 35.5%	33 26.4%	71 48.3%	35 53.0%
Died before next survey	50 23.7%	44 35.2%	59 40.1%	24 36.4%
Lost to follow-up	6 2.8%	13 10.4%	10 6.8%	8 12.1%

Comparison of the sample by survivors and those dying between surveys and by former athletes and controls.

In the total sample there were no differences with respect to any of the variables measured between those subjects who survived and those who died between each of the surveys. These results are shown in Table 14. Participation in college athletics was then included as a variable in the comparison of those who survived and those who died. Comparisons of those who survived by former

athlete and control are shown in Table 15. Comparisons of those who died between the surveys by former athlete and control are shown in Table 16. It was found that former athletes who survived had a significantly higher leisure time aerobic activity level than controls who survived. When those controls who survived were compared to those controls who died between 1975 and 1985, significant differences in total kilocalories and aerobic activity were seen. Controls who survived had significantly higher aerobic activity levels than those who died between the 1975 and 1985 surveys (Table 17). Controls who survived had a significantly higher kilocalorie intake than those who died between 1975 and 1985 (Table 18).

Hypothesis two: Summary.

The Cox Proportional Hazards Regression model indicated that aerobic activity was the only significant predictor of years of survival. Descriptive statistics showed no significant differences with respect to any of the variables measured between those who survived and those who died between the surveys. Significant differences were seen between controls who lived throughout the three surveys, and controls who died between the 1975 and 1985 surveys. Controls who survived had a significantly higher energy expenditure as aerobic activity, and a significantly higher energy intake than did controls who subsequently died. This pattern was not seen in former athletes.

Table 14. Comparison of dietary variables, BMI and aerobic activity of subjects dead after each survey and survivors who responded to each survey.

		YEAR OF QUESTIONNAIRE 1967		1975	
VARIABLE		DIED* N=94	LIVED** N=110	DIED N=83	LIVED N=104
Age/ yrs	Mean	70.8	57.7	72.6	65.9
	S.D	11.5	5.9	8.5	5.6
Kcals/ day	Mean	2125	2142	1868	2021
	S.D	585	915	913	855
% Kcals protein	Mean	15.7	16.0	15.8	15.3
	S.D	4.2	5.1	4.5	4.6
% Kcals fat	Mean	42.0	42.7	41.4	39.6
	S.D	9.0	11.5	11.6	10.6
% Kcals carb	Mean	40.4	38.3	40.7	41.4
	S.D	12.5	12.4	13.9	11.8
% Kcals alcohol	Mean	3.1	4.2	3.4	5.3
	S.D	6.2	8.3	8.0	9.9
Fat g/day	Mean	98.7	99.6	84.7	88.8
	S.D	35.1	50.3	44.9	44.8
Activity kcals/wk	Mean	N.A	N.A	1384	1624
	S.D			1735	1542
Years survived	Mean	74.3	74.5	79.4	75.7
	S.D	13.1	6.1	8.4	5.9
Height (m)	Mean	1.76	1.78	1.78	1.78
	S.D	0.06	0.06	0.06	0.06
Weight (kg)	Mean	79.1	82.1	81.8	82.2
	S.D	10.1	10.0	9.6	10.1
BMI Graduation	Mean	23.0	23.2	23.9	23.2
	S.D	2.3	2.5	2.8	2.5
BMI	Mean	25.6	25.7	25.8	25.8
	S.D	2.8	2.6	2.5	2.6

* Died before the subsequent questionnaire was issued.
** Lived throughout all three surveys.
No differences were statistically significant.

Table 15. Dietary variables, BMI and aerobic activity of survivors compared by athletes and controls.

VARIABLE		YEAR OF QUESTIONNAIRE 1967 ATHLETE N=75	1967 CONTROL N=35	1975 ATHLETE N=71	1975 CONTROL N=35
Age/ yrs	Mean	57.0	59.1	65.5	68.8
	S.D	5.1	7.2	5.2	7.1
Kcals/ day	Mean	2165	2093	1930	2218
	S.D	1039	573	937	612
% Kcals protein	Mean	16.1	15.9	16.0	14.2
	S.D	5.3	4.8	5.0	3.2
% Kcals fat	Mean	42.7	42.5	39.0	40.9
	S.D	12.5	9.3	11.4	8.6
% Kcals carb	Mean	37.8	39.5	40.6	42.9
	S.D	13.3	10.6	12.5	10.1
% Kcals alcohol	Mean	4.7	3.2	6.0	3.6
	S.D	9.1	6.3	11.2	5.9
Fat g/day	Mean	99.6	99.7	83.2	101.1
	S.D	56.0	36.0	46.8	38.1
Activity kcals/wk	Mean	N.A	N.A	1727*	1414*
	S.D			1609	1396
Years survived	Mean	74.8	76.8	75.4	76.5
	S.D	5.4	7.1	5.34	7.0
Height (m)	Mean	1.79	1.77	1.79	1.77
	S.D	0.05	0.06	0.06	0.06
Weight (kg)	Mean	83.5	79.4	83.7	79.1
	S.D	10.5	8.2	10.7	8.1
BMI Graduation	Mean	23.6	22.6	23.6	22.5
	S.D	2.5	2.2	2.5	2.2
BMI	Mean	25.9	25.4	26.0	25.3
	S.D	2.5	2.6	2.6	2.7

* significant difference between athlete and control $p<.05$ (t-test).

Table 16. Dietary variables, BMI and aerobic activity of subjects dead before the subsequent survey compared by athletes and controls.

VARIABLE		YEAR OF QUESTIONNAIRE 1967 ATHLETE N=50	1967 CONTROL N=44	1975 ATHLETE N=59	1975 CONTROL N=24
Age/ yrs	Mean	70.3	71.4	72.2	73.5
	S.D	11.4	11.6	8.5	8.5
Kcals/ day	Mean	2154	2093	1874	1854
	S.D	630	534	939	864
% Kcals protein	Mean	15.4	15.9	16.0	15.3
	S.D	3.7	4.8	4.7	3.8
% Kcals fat	Mean	43.8	40.0	40.3	43.9
	S.D	9.1	8.6	11.9	10.5
% Kcals carb	Mean	38.8	42.1	42.9	35.5
	S.D	12.8	12.0	14.2	12.0
% Kcals alcohol	Mean	3.0	3.3	2.2	6.1
	S.D	5.7	6.8	7.1	9.2
Fat g/day	Mean	103.2	93.7	83.3	88.2
	S.D	35.0	34.9	44.5	46.5
Activity kcals/wk	Mean	N.A	N.A	1405	1331
	S.D			1596	2089
Years survived	Mean	72.9	75.9	79.2	80.0
	S.D	13.9	12.2	8.5	8.3
Height (m)	Mean	1.77	1.75	1.78	1.78
	S.D	0.07	0.06	0.06	0.06
Weight (kg)	Mean	80.8	77.1	83.1	78.8
	S.D	11.6	7.7	9.9	8.1
BMI Graduation	Mean	23.4	22.6	24.6	22.3
	S.D	2.3	2.4	2.8	2.2
BMI	Mean	25.8	25.3	26.1	25.0
	S.D	3.2	2.4	2.6	2.0

No differences were statistically significant.

Table 17. Comparison of aerobic activity (Kcals/week) between athletes, controls, survivors and those who died between 1975 and 1985.

	ATHLETE	CONTROL	SIG
Survived past 1985	1727 ±1609 (n=71)	1414 ±1396 (n=35)	p<.05*
Died 1975 -1985	1405 ±1596 (n=59)	1331 ±2089 (n=24)	n.s
Sig	n.s	n.s	

* t-test.

Table 18. Comparison of energy intake (Kcals/day) between athletes, controls, survivors and those who died between 1975 and 1985.

	ATHLETE	CONTROL	SIG
Survived past 1985	1930 ±937 (n=71)	2218 ±612 (n=35)	n.s
Died 1975 -1985	1874 ±939 (n=59)	1854 ±864 (n=24)	n.s
Sig	n.s	p<.05*	

* t-test.

Hypothesis two: Discussion.

The relationship between aerobic activity and survival demonstrated in this study applies to the last ten years of life. This was at a time when the mean age of the sample was 68 years. The finding that aerobic activity is lower in those who have the lowest survival is not unexpected in this timeframe. As the subjects aged and died, they became less aerobically active. If conclusions are to be made about the influence of lifelong aerobic activity on survival it would be desirable to have data from a longer timespan than has been analyzed here. Analysis of the 1967 activity data would increase the time span over which information relating activity and mortality is available.

In view of the higher aerobic activity levels of former athletes, and the significant relationship between activity and survival, it might be expected that participation in college athletics would be related to survival. Although the higher aerobic activity of controls than former athletes was not statistically significant in this study, Quinn (1987) showed a statistically significant difference between the aerobic activity of former athletes and controls taken from the same sample as that used in this study. Former athletes expended more energy per week as aerobic activity than controls. It seems that participation in college activity results in higher activity levels after college, and this in turn is related

to survival. The observation by Paffenbarger (1984, 1986) that post-graduate level of activity rather than college participation in athletics is important in determining survival was not completely supported by the results of this study. Post-graduate activity levels were significant in determining survival, but appear also to be related to participation in college athletics.

In this study none of the dietary variables measured were significantly related to survival. This is contrary to the findings of Schlenker (1976) that total fat predicted longevity, but would support the findings of Keys (1981) that total fat and energy intake did not predict mortality.

The lack of a relationship between BMI and survival in this study supports the findings of the Seven Countries study (Keys et al. 1981). However the limitations of the data collection in the present study and the small sample size in comparison to the Seven Countries Study should be considered in comparison of these studies.

It appears that there was not a differential death rate in those with a very high or very low BMI, because there were no significant differences between the BMIs of those who survived throughout the three surveys and the BMIs of those who died between the surveys. It is possible that more subjects with both very high and very low BMIs died between the surveys than lived throughout. This would not be reflected in mean values. Equivalent

mean BMIs could result from the averaging of extreme values, and the averaging of values in the middle of the range. If this were the case, and those with very high and very low BMIs were dying, the standard deviation for this group would be higher than for the group who survived. This was not the case. There was no differential death rate for those at the ends of the range for BMI.

It is possible that many of the subjects who died between the surveys (that is, less than ten years after being surveyed), were chronically ill at the time they completed their last questionnaire. Those who lived throughout the time period, by virtue of their survival, appear to be in better health. This assumption is stronger if the comparison is made between those who died between 1967 and 1975 and those who survived beyond 1985. That is, when those who died are compared to those who lived at least ten years longer. It is possible those who died were divided into those who were chronically ill at the time of completing the questionnare, and those who were well but subsequently became ill and died, significant differences between the groups would be unmasked.

Lower energy intake and expenditure as aerobic activity was characteristic of the controls who died between 1975 and 1985, but not of former athletes who died in the same time. If low activity and caloric intake is associated with chronic illness, perhaps more controls than athletes died from chronic disease. However it is not

possible to conclude this with the data available. The standard deviations associated with aerobic activity are very large and the numbers in each group relatively small. It is possible that many of those who survived to 1985 died or will die shortly after the survey. They too may have been chronically ill in 1985. The comparison of those who died between 1975 and 1985 with those who were alive in 1985 might, in retrospect, be a comparison of two groups who died within a short time of each other. This cannot be resolved until all subjects are followed to death.

SUMMARY AND IMPLICATIONS

This study demonstrated that the only difference between former athletes and controls in this sample with respect to the variables measured was in smoking habits. Former athletes were more likely to smoke than controls. No other differences were either practically or statistically significant. Although not statistically significant in this study, former athletes had higher aerobic activity levels than controls, and as discussed previously, this difference has been found to be significant in a larger sample (Quinn, 1987).

For the total sample, the Cox model demonstrated that leisure time aerobic activity was a significant

predictor of years of survival. Subjects expending more energy as aerobic activity survived longer than those with lower levels of aerobic activity. Level of aerobic activity also differentiated subjects who survived beyond 1985 and those who died between 1975 and 1985. The dietary variables measured in this study did not predict years of survival, or differentiate subjects who lived from those who died.

Although participation in college athletics was not directly related to survival, there was an indirect link. Health behaviors established at an early age seemed to be carried into middle and old age. Former college athletes tended to be more aerobically active than controls, and increased aerobic activity was related to survival. In this study it appeared that diet and lifestyle variables in the last ten years of life were poorly related to survival. Survival benefits obtained from changing health behaviors therefore accrued over the lifetime of the subjects.

It is difficult to conclude from this study that diet and BMI do not influence survival. The relationship of lifestyle to survival is complex. This study might not have demonstrated relationships that exist in the sample, or have examined the optimal set of variables to predict survival. The relative importance of each variable in determining survival might vary from subject to subject, or within one subject with age. The standard deviation

associated with many of the variables was large, and the sample although large for experimental purposes, was small for an epidemiological study. Also, data on diet was collected only in the later years of life.

If the relationship of lifestyle to survival is to be fully characterized, longitudinal studies that monitor a wide range of variables over long periods in large numbers of subjects will be necessary. Such studies are expensive and do not produce results for many years. However this is the only way in which definitive conclusions on the effects of lifestyle on morbidity and mortality in humans can be reached. Steps should be taken to ensure that this research is supported.

LIST OF REFERENCES

LIST OF REFERENCES

Albanes D., Jones Y., Micizzi M., Mattson M. Associations between smoking and body weight in the US population. Am. J.Public Health; 77: 4, 439-444, 1987.

American Cancer Society. Cancer facts and figures. American Cancer Society. New York 1985.

Andres R., Elahi D., Tobin J.D., Miller D.C., Brant L. Impact of age on weight goals. Ann.Int.Med. 103:1030-1033,1985.

Anonymous. Body weight, health and longevity: conclusions and recommendations of the workshop. Nut.Rev. 43:61-63,1985.

Armstrong B., Doll R. Environmental factors and cancer incidence and mortality in different countries, with special reference to dietary practices. Int.J.Cancer. 15:617-631,1975.

Bannister, W.E, Brown S.R. The relative energy requirements of physical activity. In H.B.Falls (Ed.) Exercise Physiology. New York: Academic Press, 1968.

Beaton G.H., Milner J., Corey P., McGuire V., Cousins M., Stewart E., Ramos M de., Hewitt D., Grambsch P.V., Kassim N., Little J.A. Sources of variance in 24-hour dietary recall data: implications for nutrition study design and interpretation. Am.J.Clin.Nut. 32:2546-2559,1979.

Biomedical computer programs. Berkeley, California. University of California Press 1982.

Build Study 1979. Society of Actuaries and Association of Life Insurance Medical Directors. Chicago 1980.

Committee on Diet, Nutrition and Cancer. Diet, Nutrition and Cancer. Assembley of Life Sciences, National Research Council, National Academy Press, Washington D.C., 1982

Dyer A.R., Stamler J., Berkson D.M., Lindberg H.A. Relationship of relative weight and body mass to 14-year mortality in the Chicago Peoples Gas Company. J.Chron.Dis. 28:109-123,1975.

Feinleib M. Epidemiology of obesity in relation to health hazards. Ann.Int.Med. 103:1019-1024,1985.

Folsom A.R., Jacobs D.R., Caspersen C.J., Gomez-Marin O., Knudsen J. Test-retest reliability of the Minnesota leisure time physical activity questionnaire. J.Chron.Dis. 39:505-511,1986.

Frisch R.E., Wyshak G., Albright N.L., Albright T.E., Schiff I., Jones K.P., Kitschi J., Shiang E., Koff E., Marguglio M. Lower prevalence of breast cancer and cancers of the reproductive system among former college athletes compared to non-athletes. Br.J.Cancer. 52:885-891,1985.

Garn S.M., Leonard W.R., Hawthorne V.M. Three limitations of the body mass index. Am.J.Clin.Nut. 44:996-997,1986.

Garrison R.J., Feinleib M., Castelli W.P., McNamara P.M. Cigarette smoking as a confounder of the relationship between relative weight and long-term mortality. The Framingham heart study. J.A.M.A 249:2199-2203,1983.

Greenway J.C., Hiscock I.V. Mortality among Yale men. Editorial. J.A.M.A 87:175,1926.

Haan M., Kaplan G.A., Camacho T. Poverty and health: prospective evidence from the Alameda county study. Am.J.Epid. 125:989-998,1987.

Heilbrun L.K., Hankin J.H., Nomura A.M., Stemmerman G.N. Colon cancer and dietary fat, phosphorous, and calcium in Hawaiian-Japanese men. Am.J.Clin.Nut. 43:306-309,1986.

Howley E.T., Glover M.H. The caloric cost of running ond walking one mile for men and women. Med.and Sports Sci. 6:235, 1974.

Iverso G.R., Norpoth H. Analysis of variance. Sage University Paper series 1, Quantitative Applications in the Social Sciences. Sage Publications. 1982.

Jarrett R.J., Shipley M.J., Rose G. Weight and mortality in the Whitehall study. B.M.J 285:535-537, 1982.

Kahn H.A., Phillips R.L., Snowdon D.A., Choi W. Association between reported diet and all-cause mortality. Twenty-one year follow-up on 27,530 adult seventh day adventists. Am.J.Epid. 119, 775-787,1984.

Keys A. Seven Countries: A multivariate analysis of death and coronary heart disease. Cambridge: Harvard University Press, 1980.

Keys A., Aravanis C., van Buchem F.S.P., Blackburn H., Buzina R., Djordjevic B.S., Dontas A.S., Fidanza A.S., Karvonen M.J., Kimura N., Menotti A., Nedelijokovic S., Puddu V., Punsar S., Taylor H.L. The diet and all-cause death rate in the Seven Countries Study. Lancet, 2, 58-61, 1981.

Keys A., Fidanzo F., Karvonen M.J., Kimura N., Taylor H.L. Indicies of relative weight and obesity. J.Chron.Dis. 25:329-343,1972

Kushi L.H., Lew R.A., Stare F.J., Ellison C.R., El Lozy M., Bourke G., Daly L., Graham I., Hickey N., Mulcahy R., Kevany J. Diet and 20-year mortality from coronary heart disease. The Ireland-Boston Heart Study. New Engl.J.Med. 312,811-818,1985.

Leveille G., Zabik M.E., Morgan K. Nutrients in foods. Cambridge Massachusetts: The Nutrition Guild, 1983.

Leon A.S., Jacobs D.R., DeBacker G. Relationship of physical characteristics and life habits to treadmill exercise capacity. Am.J.Epidemiol.113:653-660,1981.

Lew E.A., Garfinkel L. Variations in mortality by weight among 750,000 men and women. J.Chron.Dis. 32:563-576, 1979.

Limited food intake and longevity. Nut.Rev. 40:314-316,1982.

Madden J.P., Goodman S.J., Guthrie H.A. Validity of the 24-hour recall. J.Am.Diet.Ass. 73:48-55,1978.

Michigan Department of Public Health. Personal communication, Statistical Services, Department of Vital Statistics. July 1987.

Montoye H.J., Van Huss W.D., Nevai J.W. Longevity and morbidity of college athletes: A seven-year follow-up study. J.Sportsmed and Phys.Fitness. 2:133,1962.

Montoye H.J., Van Huss W.D., Olson H.W., Peirson W.R., Hudec A.J. The longevity and morbidity of college athletes. Phi Epsilon Kappa Fraternity. 1957.

Morrison S.D. Nutrition and longevity. Nut.Rev. 41:133-142,1983.

National Center for Health Statistics. Body mass index for males 18-74 years of age by race and age, 1976-1980. Unpublished figures, 1983.

National Center for Health Statistics. Carroll M.D., Abraham S., Dresser C.M. Dietary intake source data: United States 1976-80. Vital and Health Statistics Series II No. 231. DHHS Pubn. No. (PHS) 83-1681. Public Health Service, Washington. U.S. Government Printing Office, March 1983.

National Center for Health Statistics. Health, United States, 1985. DHHS Pub. No. (PHS) 86-1232 Public Health Service. Washington D.C. US Government Printing Office, 1985.

National Center for Health Statistics. Monthly vital statistics report. Volume 1, April 1987.

Nomura A., Heibrun L.H., Stemmerman G.N. Body mass index. A good predictor of cancer in men. J.Nat.Cancer Inst. 74(2):319-323,1985.

Norgan N.G., Fero-Luzzi A. Weight-height indicies as estimators of fatness in men. Humn.Nut:Clin.Nut 36:363-372,1982.

Nube M., Kok F.J., Vandenbroucke J.P., van der Heide-Wessel C., van der Heide R.M. Scoring of prudent dietary habits and its relation to 25-year survival. J.Am.Diet.Ass. 87, 2, 171-175, 1987.

Olson H.W., Montoye H.J., Sprague H., Stephens K.E., Van Huss W.D. The longevity and morbidity of college athletes. Phys. and Sportsmed. 6:62,1978.

Paffenbarger R.S., Hyde R.T., Wing A.L., Hsieh C.C. Physical activity, all-cause mortality and longevity of college alumni. N.Engl.J.Med. 314:605-613,1986.

Paffenbarger R.S., Hyde R.T., Wing A.L., Steinmetz C.H. A natural history of athleticism and cardiovascular health. J.A.M.A 252:491-495,1984.

Palta M., Prineas R.J., Berman R., Hannan P. Comparison of self-reported and measured height and weight. Am.J.Epid. 115:223-230,1982.

Quinn T.J., The relationship between caloric expenditure and longevity among Michigan State University athletes and non-athletes. Unpublished Ph.D Dissertation, School of Health Education, Counselling Psychology and Human Performance, Michigan State University, 1987.

Rabkin S.W., Matthewson F.A.L., Hsu P.H. Relation of body weight to development of ischemic heart disease in a cohort of young North American men after a 26-year observation period: The Manitoba study. Am.J.Cardiol. 39:452-458, 1978.

Rook A. An investigation into the longevity of Cambridge sportsmen. B.M.J 1:773-777,1954.

Schlenker E.D. Nutritional status of older women. Unpublished Ph.D Dissertation, Department of Food Science and Human Nutrition, Michigan State University, 1978.

Shekelle R.B., Shryock A.M., Paul O., Lepper M., Stamler J., Liu S., Raynor W.J. Diet, serum cholesterol and death from coronary heart disease: The Western Electric Study. N.Engl.J.Med. 304:65-70,1981.

Sidney S., Farquhar J.W. Cholesterol, cancer, and public health policy. Am.J.Med. 75:494-508,1983.

Society of Actuaries. Build and Blood Pressure Study. 1959 Chicago: Society of Actuaries 1959.

Sorlie P., Gordon T., Kannel W.B. Body build and mortality. The Framingham study. J.A.M.A 243:1828-1831,1980

Steeland K., Beaumont J., Horning R. The use of regression analysis in a cohort mortality study of welders. J.Chron.Dis. 39:287-294,1986.

Stewart A.W., Jackson R.T., Ford M.A., Beaglehole R. Underestimation of relative weight by use of self-reported height and weight. Am.J.Epid. 125,1,122-126,1987.

Stunkard A.J., Albaum J.M. The accuracy of self-reported weights. Am.J.Clin.Nut. 34,1593-1599, 1981.

Taylor H.L., Jacobs D.R., Schucker B. A questionnaire for the assessment of leisure time physical activities. J.Chron.Dis. 31:741-755,1978.

U.S. Department of Agriculture. Nutrient intakes: Individuals in 48 states, year 1977-78. Nationwide Food Consumption Survey 1977-78. Report No. I-2, Consumer Nutrition Division, Human Nutrition Information Service, U.S.D.A. U.S. Government Printing Office, August 1983.

U.S. Department of Commerce Bureau of the Census. Historical statistics of the United States. Colonial times to 1970. Part 1. 93rd Congress 1st Session. House document No. 93-78, 1978.

Vandenbrouke J.P., Mauritz B.J., deBruin A., Verheesen J.H.H., Heide-Wessel C. van der, Heide R.M. van der. Weight, smoking and mortality. J.A.M.A 252:2895-2860,1984.

Van Itallie T.B. Health implications of overweight and obesity in the United States. Ann.Int.Med. 103:983-988,1985.

Wilson B.R.A. Somatotype, mortality, and morbidity of former Michigan State University athletes and non-athletes. Unpublished Ph.D Dissertation, School of Health Education, Counselling Psychology and Human Performance, Michigan State University, 1986.

Yu B.P., Masoro E.J., Murata I., Bertrand H.A., Lynd F.T. Life span study of SPF Fischer male rats fed ad libitum or restricted diets: Longevity, growth, lean body mass and disease. J.Gerontol. 37:130-141,1982.

1983 Metropolitan Height and Weight Tables. Statistical Bulletin, Metropolitan Life Insurance Company. 64:3,1983.

APPENDIX 1

THE QUESTIONNAIRES

1952, 1967, 1975, 1985

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 (check one)	After College Years (check one)	Comments
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: "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

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 (check one)	After College Years (check one)	Comments
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 1958." "Did not play football during junior college year on account of fracture or operation." "Etc _____." _____

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) ☐
   C. 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 puddings			
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 2

CALORIC STANDARDS FOR THE MICHIGAN STATE UNIVERSITY LONGEVITY STUDY ACTIVITIES

CALORIC STANDARDS FOR THE MICHIGAN STATE UNIVERSITY LONGEVITY STUDY ACTIVITIES.
(QUINN, 1987)

		Kcal/min/lb
1)	Fishing (bank,boat,ice).....	.020
2)	Fishing (wading).....	.028
3)	Archery.....	.029
4)	Badmington.....	.040
5)	Baseball (hard,soft).....	.031
6)	Basketball.....	.045
7)	Bicycle (pleasure,5 mph)*.....	.029
8)	Tobogganing (sled).....	.025
9)	Bowling.....	.029
10)	Canoeing (rowing,leisure)*.....	.020
11)	Jogging*.....	.074
12)	Curling.....	.020
13)	Fencing.....	.033
14)	Gardening.....	.039
15)	Lawn mowing (riding).....	.017
16)	Lawn mowing (power mower)*.....	.051
17)	Lawn mowing (hand mower)*.....	.055
18)	Snow shovelling.....	.039
19)	Golf (walking)*.....	.039
20)	Golf (power cart).....	.020
21)	Handball.....	.080
22)	Walking (backpacking)*.....	.050
23)	Walking (cross country)*.....	.044
24)	Walking (mountain climbing)*.....	.055
25)	Walking (pleasure)*.....	.036
26)	Home workshop (carpentry).....	.023
27)	Horseback riding (trotting).....	.045
28)	Horseshoe pitching.....	.023
29)	Hunting (bow and gun).....	.040
30)	Sailing (ice and water).....	.020
31)	Judo.....	.089
32)	Paddle tennis.....	.033
33)	Rowing (sculling)*.....	.029
34)	Shuffleboard.....	.020
35)	Skating (ice,roller)*.....	.038
36)	Skiing (downhill).....	.064
37)	Skiing (cross country)*.....	.080
38)	Skiing (water).....	.052
39)	Snowshoeing (2.3 mph)*.....	.060
40)	Dancing (ballroom)*.....	.029
41)	Dancing (square)*.....	.045
42)	Swimming (pleasure)*.....	.045
43)	Swimming (exercise)*.....	.058
44)	Table tennis.....	.031
45)	Tennis (singles).....	.050
46)	Tennis (doubles).....	.045
47)	Volleyball.....	.022
48)	Weight lifting.....	.049
49)	Calisthenics (home)*.....	.033
50)	Calisthenics (health club)*.....	.040

* ACTIVITIES UTILIZED IN THE AEROBIC CALORIC EXPENDITURE CALCULATIONS.

APPENDIX 3

MSU NUTRIENT DATABASE COMPUTER COMMANDS USED

MSU NUTRIENT DATA BASE COMMAND STATEMENTS USED

```
*JOBCARD*,RG1,JC10000,L1000,GE1,PE1,CM60000.
HAL,LIB,UNSUP.
APLIB9,TT3368,R*DEMORAN=DEMOIN,R*FOODUPN=FOODTBL.
APLIB9,TT3279,*B89704.
ATTACH,FOODIN,FINALDIETS.
COPYBR,INPUT,PARAM.
FILE,REPORTO,FO=SQ,BFS=2054.
FILE,FOODIN,FO=SQ,BFS=2054.
SWITCH,6,ON.
SWITCH,5,OFF.
B89704.
*CATALOG,RDAOUT,FINALRDA,ID=APJMH,RP=1.
*CATALOG,NUTOUT,FINALNUT,ID=APJMH,RP=1.
*CATALOG,PERCENT,FINALPERCENT,RP=1,ID=APJMH.
CATALOG,REPORTO,FINALREPORT,RP=1,ID=APJMH.
COPYBF,REPORTO.
EXIT.
CATALOG,REPORTO,FINALREPORT,RP=1,ID=APJMH.
REWIND,REPORTO.
COPYBF,REPORTO.
*EOR
OUT  YYYNYYY99999
NUT1 NB
YYYYYYYYYYNYNNNNNNNNNNNNYNYYYNNNNNNYYYYYYYYYNYYNNNNNYNYYYYYY
YYNYNYYNNNYY
NUT2 YNNNNNNN
*EOR
MEALCARDS
GO
```