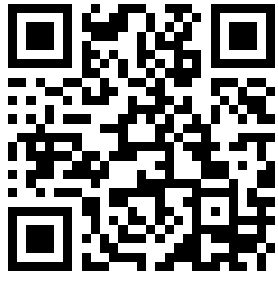


THE FRAMINGHAM STUDY

An Epidemiological Investigation
of
Cardiovascular Disease

Section 24

The Framingham Diet Study: Diet and the Regulation of Serum Cholesterol

THE FRAMINGHAM STUDY

An Epidemiological Investigation of Cardiovascular Disease

Editors: William B. Kannel, M.D. and Tavia Gordon

Section 24: The Framingham diet study: Diet and the regulation of serum cholesterol.

Section 24

Tables

Section 24

Tables (continued)

Section 24

Tables (continued)

Figures

Figures (continued)

Framingham Study

Editorial Note:

This report is based on a selection from a large body of tabular material prepared since the completion of data collection for the Framingham Diet Study. Unfortunately, these data were never incorporated into a definitive report by the original investigators and a large amount of very careful and thoughtful work has lain unused in the Framingham files. I have organized and edited this material, and to a limited extent supplemented it, so that it can be made part of the record of the Framingham Study. While some effort was made to organize this material in a uniform manner certain minor discrepancies, for example in age groupings, remain. Needless to say, I alone am responsible for the selection and organization of the material and the conclusions are mine and do not necessarily reflect the judgements of the original investigators.

Such a disinterment and reconstruction leaves a great deal to be desired, including a proper credit to the people who did the original work and the large number of persons who had input into the planning, collection and analysis of the data. Two essential contributions must be mentioned, however. George V. Mann, M.D. had primary responsibility for planning and supervising the study and Georgiana Pearson was the dietitian responsible for the data collection.

Tavia Gordon

The Framingham Diet Study: Diet and the Regulation of Serum Cholesterol

In 1957-1960 a diet assessment was undertaken for a sample of the Framingham Study cohort on their fifth biennial examination.* The method used was a modification of the dietary interview developed by Burke (1) and was directed to evaluating the "usual" long-term intake of each person interviewed.

A sample of 1049 persons was drawn according to an elaborate sampling scheme. A 25 percent random sample was drawn from a listing of the original sample respondents. This sample was then modified as follows:

(a) One half of the women sampled were removed.

(b) All persons who were known dead were removed (25 men, 7 women).

(c) All persons who had missed the last two consecutive examinations were removed (50 men, 25 women).

(d) All persons with the diagnosis of heart disease or definite hypertension were removed (Table 1). (Persons who were diagnosed as having these conditions subsequent to the sampling but prior to the interview were, however, retained). The diagnoses comprised any form of definite heart disease, including myocardial infarction, angina pectoris, and rheumatic heart disease. A total of 173 persons, 124 men and 49 women, were removed for these reasons. However, these were the only medical exclusions and other persons with known disease, some of them involving dietary therapy, are included in the dietary sample.

* A few interviews were obtained on the fourth and sixth examinations.

---

1 Burke, B.S. The dietary history as a tool in research. J. Amer. Diet. Assoc. 23: 1041-1046, December 1947.

The wives of all the men selected for the dietary sample were then added in order to have these women available to supplement their husband's stories. The husbands of women in the random sample were not included. Since the degree of lipidemia is involved in the dietary hypotheses of atherogenesis and since this attribute had been measured in past examinations it was used as a criterion for augmenting the dietary sample. For this purpose, all male subjects in the otherwise qualified population with cholesterol levels* of 300 mg% or more or below 170 mg% were included in the dietary sample as "high cholesterol" and "low cholesterol" males, respectively. These groups promised to be unusually potent in the evaluation of dietary hypotheses. The wives of these men were also included. These methods yielded a total sample of 1049 subjects, 503 men and 546 women. A summary of the dietary sample is shown in Table 2. These persons were to be studied in a period of 36 months.

Of the 1049 persons in the sample only 912 yielded successful interviews. The other 137 were accounted for as follows:

Not interviewed	61
Refused	33
Dead	5
Moved	23
Unsuccessful interview	76
Failed	10
No pattern	11
Dieting	11
Poor communication	4
Uncooperative	31
Other	9

It was not intended by this procedure to provide an estimate of the usual diets in the Framingham Study group as a whole but rather to collect information to test the hypotheses that "The regulation of the level of

* On the initial study determination.

serum cholesterol and the development of coronary heart disease are related to

1. The caloric balance
2. Level of animal fat intake
3. Level of vegetable fat intake
4. Level of protein intake
5. Level of cholesterol intake . . ."

This paper presents data relating to the hypotheses respecting the regulation of serum cholesterol. To these has been added the hypothesis that serum cholesterol level is related to

6. Level of the ratio of complex to simple carbohydrates (C/S ratio).

THE MEASUREMENT OF DIET

Two reports have appeared describing the techniques used and the reliability of the measurement of dietary intake (2,3). While the measurement of nutrient intake is exceedingly difficult the general conclusion of these methodological studies was that the procedure provided a relatively valid and reliable measure of usual daily intake.

However, diet interviews were obtained over a 4-year period and it may well be asked whether the technique remained stable over that period of time. Figures 1 and 2 indicate that the total caloric intake reported for the study group decreased measurably over the 4-year period.

In particular, levels during the last year of interviewing were substantially less than during the first three years. If one specific nutrient is considered--total grams of fat--a parallel trend is noted, as

---

2 Dawber, T.R., Pearson, G., Anderson, P., Mann, G.V., Kannel, W.B., Shurtleff, D., McNamara, P.M. Dietary assessment in the epidemiologic study of coronary heart disease: the Framingham Study. Amer. J. Clinical Nutrition 11: 226-234, September 1962.

3 Mann, G.V., Pearson, G., Gordon, T., Dawber, T.R., Lyell, L.P., Shurtleff, D. Diet and cardiovascular disease in the Framingham Study. Amer. J. Clinical Nutrition 11: 200-226, September 1962.

might be anticipated. That this is not easily explained by a change with time in the persons interviewed may be judged from Figures 5 and 6 which show trends in body weight. While the average weight was lower for men interviewed at the end of the study than men interviewed at the beginning of the study (a finding that might be construed as consistent with trends for total caloric intake) the opposite was true for women interviewed.

Figures 1 and 2 might also be examined for evidence of seasonal variation in reported intake. The interview was intended to elicit "usual" intake; that is, something more general than the recent diet of the individual. If this effort was successful there should be no evidence of seasonality in reported intake. Despite substantial variation from quarter to quarter in total calories reported, there is no evidence that this variation followed a seasonal cycle.

USUAL INTAKE

While it is difficult to specify exactly how the diet for this study group compares with that for the Framingham cohort as a whole or how the Framingham diet compares with that for United States adults generally, there may be some interest in the findings in a carefully evaluated group of American adults (Tables 3 and 4).

On the average, men consumed 3156 calories and women consumed 2142 calories. Some 40 percent of these calories came from fat and 70 percent of the fat was from animal sources. (There was little difference between men and women in these proportions). Caloric intake decreased with age in both men and women but the percent of calories from fat was about the same across the age range. A slightly larger proportion of the fat came

from animal sources in older persons.

Distributions of various nutrient measures are given in Figures 7-20. There is obviously considerable variation in all these measures from one person to another. This is also evident in the standard deviations given in Table 3.

While caloric intake had a considerable range in the study group, there was a heavy concentration of reported intakes for men and women at the modal values (Figure 7). This appears visually in the marked "peakedness" of these curves. When caloric intake is expressed as calories per pound of body weight this peakedness becomes less marked (Figure 8). The curves for the major nutrients also tend to have a large number of values at the mode combined with considerable dispersion (Figures 9-20). Probably the most important feature of these curves is the evidence they show that diet as reported for this Study Group is by no means uniform. There is a wide range of intake.

All such assessments are, of course, dependent on one's perspective. In terms of diets in which only 15 or 20 percent of the calories come from fat almost all values for the Study Group are "high," with roughly 90 percent of the group receiving 30 percent or more of their calories from fat. Clearly, if the effects being assessed appear only above or below some threshhold value, a population which was truncated at that value would be unsuitable for studying the effect.

An additional piece of information of some interest is the correlation between the major diet components and total caloric intake (Table 5).

It will be noted that the major nutrients correlate highly with total caloric intake. Thus, it would be anticipated that any findings for total caloric intake would generally prefigure the findings for the major nutrients. On the other hand the various ratios and percentages tend to have a much lower correlation with total caloric intake.

RELATION OF SPECIFIED DIET CHARACTERISTICS TO SERUM CHOLESTEROL LEVELS

The relationship of specified diet characteristics to serum cholesterol levels is summarized briefly in Table 6, which gives correlation coefficients with serum cholesterol for a number of diet characteristics. The serum cholesterol value used is that determined at the time of the interview.

Caloric balance

The following measures related to caloric balance were looked at for a possible relation to serum cholesterol levels.

a) Calories per day

b) Daily caloric intake per pound of body weight

In addition, each measure (a or b) was examined separately at specified levels of physical activity. Calories per day showed a slight negative association with serum cholesterol level (over all age groups) in men but no association in women. This is evident from the correlation coefficients.

When the population is divided into persons above and below median caloric intake, (or median caloric intake per pound of body weight) those men with higher caloric intake tend to have lower serum cholesterol levels; but there is no similar difference found in women (Tables 7 and 8).

This finding is somewhat puzzling and it is reasonable to inquire if this is related in some way to the level of physical activity. In a given weight group persons who report higher activity levels also report higher caloric intakes (Table 9). (This may be taken as a validation of both the diet interviews and the physical activity histories). What is more, relative weight tended to be greater in men who were more sedentary (caloric intake fixed) or who had a higher level of caloric intake (physical activity fixed). Again this tends to validate the measuring techniques used. These associations appear to be considerably stronger for men than women, although this may well be a function of the paucity of women reporting higher levels of physical activity.

If, then, the population is divided into high and low classes on the basis of both physical activity and daily caloric intake, men in the same physical activity class tend to have higher serum cholesterol levels at lower caloric intake (Table 10). This finding is contrary to expectation.

Constructing a regression equation in the form

$$\text{Serum cholesterol} = a + b\,(\text{physical activity index}) + c\,(\text{calories per day}) + d\,(\text{Framingham relative weight})$$

we find that for men aged 37-49 the regression is statistically significant and that it is near statistical significance at 50-59. These regressions are primarily accounted for by the negative coefficient assigned to the daily caloric intake. For men 60-69 and for women the regressions are not statistically significant (Table 11). These findings are generally consistent with the tabular material already discussed.

Level of fat intake

The following measures related to fat intake were used:

a) Grams of fat per day

b) Grams of animal fat per day

c) Percent calories from fat

d) Ratio of daily intake of plant fat to animal fat.

Paralleling the findings for total calories there is a slight negative association between daily intake of total fat (and also of animal fat) with serum cholesterol level, in men but not in women.* This parallel is not surprising given the high correlation between fat intake and total caloric intake. No association between percent of calories from fat and serum cholesterol level was shown; nor between ratio of plant fat intake to animal fat intake and serum cholesterol level (Tables 12-15).

Protein intake

There was a trivial negative correlation between daily protein intake (in grams) and serum cholesterol level (Table 6).*

C/S ratio

The evidence in Table 16 when taken in the context of Table 6 can be interpreted as showing no relationship between C/S ratio and serum cholesterol level.

Dietary cholesterol

There is no indication of a relationship between dietary cholesterol and serum cholesterol level (Table 17).* If the intake level of animal fat is held constant there is still no relation of cholesterol intake to serum cholesterol level (Table 18).* If (further) a multiple regression

* The relationships indicated are unchanged if the specified nutrients are expressed in grams per pound of body weight.

is calculated in the form

serum cholesterol = a + b (animal fat) + c (dietary cholesterol)

there is also little suggestion of an association between this pair of variables and serum cholesterol level (Table 19). The age group 60-69 in men is the only exception and it may be due to sampling variability. In that age-sex group a significant positive correlation between dietary cholesterol and serum cholesterol is translated into a significant bivariate regression. (Since the correlation between cholesterol intake and fat intake ranges between .606 and .717 in these various age-sex groups, it is unlikely that relationships not evident for either singly would be evident for both jointly.)

Other analyses

The failure to turn up any positive association between food intake and serum cholesterol level in the Framingham Diet Study led to the exploration of a large number of variant analyses. These were uniformly unsuccessful in finding expected relationships. Only a fraction of these explorations are included in this report.

Two other tables might be considered beyond those already presented. One is a look at mean dietary constituents for persons with "high" (300 mg% or greater) and "low" (less than 180 mg%) cholesterol levels (Table 20). These groups are defined not by the serum cholesterol measurements used for drawing the diet sample but by the blood measurements made at the time of the diet interview. Another is a multiple regression using some key diet variables (Table 21).

Neither alters the generally negative conclusions already arrived

at. The regression equation for men 50-59 is statistically significant (this may be interpreted as a reflection of the significant negative correlation between total caloric intake and serum cholesterol level in this age-sex group) but the regression equations for the other age-sex groups are not. It is evident that the coefficients assigned to the independent variables follow no clear pattern from one age group to another. (The multiple correlation coefficients, while low, look large compared to the univariate correlation coefficients. This is a reflection of the use of 7 independent regressors rather than one but only for 50-59 year old men does the multiple correlation coefficient achieve the 5% significance level.)

Energy balance

Food intake is part of an equation which includes relative weight and physical activity. This is a dynamic relationship in which time is an important dimension. The cross-sectional data obtained by this study may reflect this relationship poorly, if at all. The following correlations from the Framingham Diet Study are not very impressive.

	Correlation of Framingham relative weight with		
	Physical Activity Index	Calories/day	Both
Men			
37-49	.075 (.030)	.121 (.167)	.125
50-59	-.008 (-.032)	.159 (.185)	.175
60-69	-.083 (-.089)	.120 (.110)	.188
Women			
37-49	.048 (.024)	.007 (.033)	.048
50-59	.046 (.026)	.006 (-.011)	.046
60-69	-.196 (-.157)	-.040 (.013)	.199

The parenthetical entries are correlations with actual weight. These differ trivially from the correlations with relative weight.

The correlation of the physical activity index and daily intake of calories as expressed in the study data is moderate for men and poor for women:

	Men	Women
37-49 years	.394	.075
50-59 years	.372	.135
60-69 years	.411	.043

Considering the presumptive reliability of these two measurements the correlations for men are particularly interesting. Taking the data at face value (that is, ignoring sampling variation) one of these measurements, at least, should have a better than 0.6 correlation with the "true" values it purports to describe. While this is far from ideal, it is better than is sometimes suggested. In all likelihood the better measurement in men is the measurement of diet so that the estimate of 0.6 is really on the low side.

(Given certain simplifying assumptions respecting measurement error, $r = Rr_x r_y$ where r is the sample correlation between two variables, R is the true correlation, r_x is the correlation between the sample values and true values for one variable and r_y is the corresponding correlation for the other variable. If we make the worst assumption (that R = 1) and assume $r_x = r_y = r_i$, then $r_i \geq \sqrt{r}$. Reference (1) gives an estimate of the coefficient of reliability for calories based on 33 re-interviews of $r_{x_1 x_2} = 0.84$. $r_x = \sqrt{r_{x_1 x_2}}$ so that another estimate of r_x is 0.92. Thus, the estimate of r_x given in the text ($r_x \geq .6$) would appear to be a conservative one).

The low correlation between physical activity and caloric intake, on the one hand, and relative weight on the other, may be accounted for by the fact that for most people caloric intake and energy expenditure

are closely balanced and that relative weight is the end product of minor differences between them accumulated over an extended period of time.

Thus, if the balance between energy intake and expenditure is critical in the control of serum cholesterol levels it might appear in the relationship of serum cholesterol level to weight change. An equation can be made in the form

serum cholesterol (at Exam 4) = a + b (FRW) + c (change in FRW)

where FRW is the average relative weight over the first four examinations and the change in FRW is measured by the Exam 4 FRW minus the Exam 1 FRW (Table 22). In this analysis we use data from the entire Framingham cohort. Generally speaking, both weight and weight change appear to have a weak association with serum cholesterol level. Thus, energy balance, as contrasted with diet as such, does appear to have some relation to serum cholesterol level in this population, albeit not an impressive relation. The data on energy balance, however, deserve a more extended analysis than would be appropriate in this report.

RELATIONSHIP OF DIETARY IRON AND BLOOD HEMOGLOBIN

A secondary hypothesis of the Framingham Diet Study, quite unrelated to the atherogenesis study, was that there was a direct relationship between the intake of iron and blood hemoglobin levels. To the contrary, the study data suggest a weak negative association, not significantly different from zero in most specific age-sex groups but always negative, always about the same order of magnitude, and (for all age-sex groups combined) statistically significant.

Men	Number	Correlation
37-49	209	-0.075
50-59	131	-0.091
60-69	83	-0.055
Women		
37-49	221	-0.117
50-59	142	-0.084
60-69	75	-0.041

Whether this arises from a tendency of persons to take more iron in their diet when informed they have "marginal anemia" is difficult to say for sure but it seems unlikely. If mean intakes of dietary iron are examined for persons with low and high blood hemoglobin levels there is no indication of a dramatically high intake of iron in persons having low blood hemoglobin levels. Rather, there is a trivial difference between the intakes for persons with high and low blood hemoglobin levels (Table 23).

RELATIONSHIP OF DIET TO CHD INCIDENCE

In undertaking the diet study at Framingham the primary interest was, of course, in the relation of diet to the development of coronary heart disease (CHD). It was felt, however, that any such relationship would be an indirect one, diet influencing serum cholesterol level and serum cholesterol level influencing the risk of CHD. However, no relationship could be discerned within the study cohort between food intake and serum cholesterol level. It does not necessarily follow, however, that food intake is unrelated to CHD incidence by some other unspecified mechanism.

In the period between the taking of the diet interviews and the end of the 16-year follow-up, 47 cases of *de novo* CHD developed in the Diet

Study group. The means for all the diet variables measured were practically the same for these cases as for the original cohort at risk (Table 24). There is, in short, no suggestion of any relation between diet and the subsequent development of CHD in the study group, despite a distinct elevation of serum cholesterol level in men developing CHD. (The large mean difference in serum cholesterol levels for men (Table 24) is exaggerated by the sampling scheme which oversampled men with very high and very low serum cholesterol levels.)

CONCLUSIONS

With one exception there was no discernible association between reported diet intake and serum cholesterol level in the Framingham Diet Study Group. The one exception was a weak negative association between caloric intake and serum cholesterol level in men.

While negative findings on a sample can be argued to be consistent with positive findings in the universe, the data strongly suggest that if there really is any association between diet intake and serum cholesterol level in the Framingham Study population it is probably a weak one.

It is important to be perfectly clear what these findings mean and what they do not mean. They mean that in the Framingham Study Group, diet (as measured here) is not associated with concurrent differentials in serum cholesterol level. It does not mean that the difference between Framingham and some other population (say the people of Japan) in serum cholesterol level is unrelated to differences between these populations in diet. Still less does it mean that serum cholesterol levels cannot be changed by changes in dietary intake.

On the other hand, these findings suggest a cautionary note with respect to hypotheses relating diet to serum cholesterol levels. There is a considerable range of serum cholesterol levels within the Framingham Study Group. Something explains this inter-individual variation, but it is not diet (as measured here). Clearly if there is to be an attempt to manipulate serum cholesterol level in a general population it would be desirable to know what these powerful but unspecified forces are.

We have repeatedly stated that the findings relate to diet as measured here. This implies that using some other technique for measuring diet intake or measuring some other dietary parameters than this study did might yield different conclusions. It is important to recognize this possibility. It is also important in considering some other parameter to determine whether or not it is highly correlated with a parameter included in this study. Furthermore, it should be remembered that, for men at least, internal evidence indicates that the measurement of food intake was relatively good in this study.

Two parameters other than serum cholesterol were also considered. One was blood hemoglobin--was it directly related to iron intake? It was found there was, in fact, a very weak inverse relationship between these two variables, whereas (of course) the postulated relationship was in the other direction. The other was coronary heart disease incidence--was it related prospectively to diet? No relationship was found.

TABLES

Table 1. Exclusions from Framingham dietary sample because of preexisting disease.

	Total	Men	Women
Total with preexisting disease	173	124	49
All heart disease, definite*	70	51	19
Myocardial infarction	14	14	--
Angina pectoris	17	13	4
Rheumatic heart disease	22	12	10
Hypertensive heart disease	17	12	5
Hypertension, definite	103	73	30

NOTE: No man remained in the diet sample if he had any of the specified conditions on his last exam. Some women in the sample do have some of these conditions, since there was no clinical selection for those drawn as spouses of men in the "diet sample" or with high or low cholesterol.

* When more than one of these conditions were present the subject was assigned to the first category on the list.

Table 2. Summary description of the Framingham dietary sample

Sex and Sample Category	Total	Age at time of interview			
		37-39	40-49	50-59	60-69
Total (both sexes)	1,049	49	455	328	217
Men					
Total	503	26	212	155	110
Random sample	360	17	141	119	83
Low cholesterol	92	8	47	21	16
High cholesterol	51	1	24	15	11
Women					
Total	546	23	243	173	107
Random sample	238	7	98	74	59
Wives of men in random sample	229	11	105	75	38
Wives of men with high or low cholesterol	79	5	40	24	10

Table 3. Mean and standard deviation of some characteristics of the average daily intake of food, by sex: Framingham Diet Study

Characteristic	Men		Women	
	Mean	S.D.	Mean	S.D.
Number of persons	437		475	
Calories	3156	701.7	2142	561.1
Protein (grams)				
Total	124.	24.1	88	19.6
Animal	94	20.1	68	16.6
Plant	30	9.2	20	6.6
Fat (grams)				
Total	136	36.8	96	31.3
Animal	98	30.7	65	24.3
Plant	38	18.0	30	16.4
Carbohydrate (grams)				
Total	327	91.9	228	70.2
Simple	170	58.0	124	44.3
Complex	157	49.2	104	37.5
Cholesterol (mg)	704	220.9	492	170.0
Iron (mg)	19	3.8	14	3.2
Percent calories from				
Fat	39	5.7	40	5.7
Simple carbohydrate	21	5.0	23	5.9
Complex carbohydrate	20	4.2	19	4.6
Percent fat from animal sources	72	11.0	69	12.1
Ratio of				
Fatty acids: polyunsaturated/saturated	0.41	0.13	0.42	0.13
Carbohydrates: complex/simple	1.00	0.39	0.90	0.37

Table 4. Mean of some characteristics of the average daily intake of food by age for men : Framingham Diet Study

Characteristic	Total	37-39	40-44	45-49	50-54	55-59	60-64	64-69
Number of persons	437	33	97	87	81	52	6[illegible]	24
Calories	3156	3330	3260	3257	3121	3046	3014	2853
Protein (grams)								
Total	124	129	124	126	125	124	122	113
Animal	94	97	92	95	96	95	95	87
Plant	30	32	33	31	30	28	27	26
Fat (grams)								
Total	136	144	141	139	135	133	139	125
Animal	98	103	98	100	97	98	97	93
Plant	38	42	43	39	38	35	33	32
Carbohydrate (grams)								
Total	327	357	343	334	318	316	304	301
Simple	170	189	172	174	162	172	160	161
Complex	157	168	171	161	156	143	143	140
Cholesterol (mg)	704	668	666	701	692	737	772	710
Iron (mg)	19	19	19	19	19	18	18	18
Percent calories from								
Fat	39	39	39	38	39	39	39	39
Simple carbohydrate	21	22	21	21	21	22	21	23
Complex carbohydrate	20	20	21	20	20	19	19	20
Percent fat from animal sources	72	71	69	72	71	73	75	74
Ratio of								
Carbohydrates: complex/simple	0.99	0.93	1.04	0.99	1.05	0.92	0.94	0.92

Table 4. Mean of some characteristics of the average daily intake of food by age for women: Framingham Diet Study

Characteristic	Total	37-39	40-44	45-49	50-54	55-59	60-64	64-69
Number of persons	475	28	111	100	90	63	55	28
Calories	2142	2508	2171	2181	2131	2068	1951	2098
Protein (grams)								
Total	88	95	86	90	90	87	84	89
Animal	68	70	65	70	70	67	65	69
Plant	20	24	21	21	20	19	19	20
Fat (grams)								
Total	96	114	97	100	94	90	85	94
Animal	65	73	65	68	65	63	60	67
Plant	30	41	32	31	29	27	25	27
Carbohydrate (grams)								
Total	228	271	230	225	224	225	214	230
Simple	124	151	119	120	126	127	121	125
Complex	104	121	112	106	98	98	93	105
Cholesterol (mg)	492	548	461	509	512	468	482	504
Iron (mg)	14	15	14	14	14	14	14	14
Percent calories from								
Fat	40	41	40	40	39	39	39	40
Simple carbohydrate	23	24	22	22	24	25	25	24
Complex carbohydrate	19	19	20	19	18	19	19	21
Percent fat from animal sources	69	65	67	69	69	70	71	71
Ratio of								
Carbohydrates: complex/simple	0.89	0.83	1.01	0.95	0.81	0.81	0.82	0.91

Table 5. Correlation of calories with some other characteristics of the average daily intake of food by sex and age: Framingham Diet Study

Characteristic	Men			Women		
	37-49	50-59	60-69	37-49	50-59	60-69
Number of persons	217	133	87	239	153	83
Protein						
Total	.77	.77	.75	.80	.72	.72
Animal	.56	.57	.61	.62	.55	.57
Plant	.79	.77	.79	.82	.79	.71
Fat						
Total	.82	.82	.78	.92	.90	.88
Animal	.68	.68	.66	.72	.74	.80
Plant	.58	.46	.39	.71	.62	.36
Carbohydrate						
Total	.82	.87	.82	.87	.84	.91
Simple	.69	.74	.68	.73	.66	.80
Complex	.73	.74	.69	.80	.78	.73
Cholesterol	.51	.51	.41	.55	.62	.68
Iron	.76	.74	.76	.80	.73	.72
Percent calories from						
Fat	.03	-.02	.09	.28	.35	.21
Simple carbohydrate	.07	.19	-.005	.01	-.21	.19
Complex carbohydrate	.02	.02	-.005	.09	.15	.14
Percent fat from animal sources	-.14	-.002	-.01	-.22	-.12	.08
Ratio of						
Fatty acids: polyunsaturated/saturated	.03	-.02	.01	-.11	-.003	-.05
Carbohydrates: complex/simple	.01	-.15	-.01	.06	.19	-.08

Table 6. Correlation of serum cholesterol with some characteristics of the average daily intake of food by age and sex: Framingham Diet Study

Characteristic	Men			Women		
	37-49	50-59	60-69	37-49	50-59	60-69
Number of persons	213	132	86	221	143	78
Calories	-.09	-.20	-.08	-.06	.05	.05
Calories per body weight	-.17	-.21	-.02	-.10	.04	.13
Protein						
Total	-.04	-.07	-.01	-.03	-.03	-.10
Animal	.003	.01	.04	.01	-.02	-.08
Plant	-.10	-.20	-.15	-.12	-.03	-.10
Fat						
Total	-.06	-.10	-.02	-.11	.15	.04
Animal	-.05	-.06	-.002	-.04	.10	.04
Plant	-.04	-.08	-.04	-.14	.12	.01
Carbohydrate						
Total	-.12	-.32	-.22	-.06	-.04	.07
Simple	-.12	-.30	-.14	.01	-.05	.14
Complex	-.10	-.23	-.23	-.12	-.02	-.06
Cholesterol	-.05	-.06	.23	-.11	.04	.05
Iron	-.06	-.07	-.04	-.09	.01	-.07
Percent calories from						
Fat	.02	.11	.02	-.14	.26	-.003
Simple carbohydrate	-.06	-.29	-.14	.10	-.13	.15
Complex carbohydrate	-.06	-.13	-.23	-.11	-.07	-.13
Percent fat from animal sources	-.01	.04	.03	.10	-.06	-.002
Ratio of						
Fatty acids: polyunsaturated/saturated	.09	-.03	-.05	-.04	.06	-.04
Carbohydrates: complex/simple	.02	.09	.01	-.08	.01	-.19

Table 7. Mean serum cholesterol level according to daily caloric intake: Framingham Diet Study

	Number		Mean Serum Cholesterol Level	
Men	Above Median*	Below Median*	Above Median*	Below Median*
37-44	72	56	229	235
45-54	84	82	235	253
55-69	57	80	230	238
Total	213	218	231	243
Women				
37-44	78	52	226	216
45-54	89	86	243	246
55-69	53	84	260	263
Total	220	222	241	245

* Median daily caloric intake: Men = 3124.79; women = 2081.08

NOTE: There are 6 men with unknown serum cholesterol. 5 are in the above median daily caloric intake and 1 in the below group. There are 33 women with unknown serum cholesterol. 17 are in the above daily caloric intake and 16 in the below group. Serum cholesterol is measured in mg%.

Table 8. Mean serum cholesterol level according to daily caloric intake per pound of body weight: Framingham Diet Study

	Number		Mean Serum Cholesterol Level	
Men	Above Median*	Below Median*	Above Median *	Below Median*
37-44	67	61	231	232
45-54	79	87	225	261
55-69	66	71	229	239
Total	212	219	228	246
Women				
37-44	73	57	225	217
45-54	96	79	242	247
55-69	52	85	257	264
Total	221	221	240	246

* Median daily caloric intake per pound of body weight: Men = 18.66; women = 15.26

Table 9. Daily caloric intake by Physical Activity Index and body weight: Framingham Diet Study

Physical Activity Index *	Number		Mean Daily Caloric Intake		
	Above Median**	Below Median**	Total	Above Median**	Below Median**
Men/37-49					
< 30	24	14	2878	2965	2729
30-34	52	38	3209	3335	3036
34+	38	36	3557	3637	3473
Unknown	5	10	3208	3551	3037
Total	119	98	3270	3366	3153
Men/50-69					
< 30	40	32	2855	2905	2794
30-34	34	48	2927	3171	2755
34+	23	40	3399	3454	3368
Unknown	2	1	3272	2875	4067
Total	99	121	3043	3123	2979
Women/37-49					
< 30	25	25	2088	1992	2185
30-34	61	73	2253	2254	2251
34+	16	23	2258	2350	2194
Unknown	10	6	2187	2180	2195
Total	112	127	2215	2202	2225
Women/50-69					
< 30	52	39	2016	2023	2007
30-34	49	55	2068	2030	2102
34+	16	11	2162	2047	2329
Unknown	8	6	2227	2156	2322
Total	125	111	2068	2037	2103

* Physical Activity Index is based on the average number of hours per day spent at various levels of activity and equals 1.0 (hours sleep or rest) + 1.1 (hours sedentary) + 1.5 (hours slight activity) + 2.4 (hours moderate activity) + 5.0 (hours heavy activity).

** Median weight: Men = 167 pounds; women = 136 pounds

Table 10. Mean cholesterol level according to Physical Activity Index and daily caloric intake by sex and age: Framingham Diet Study

Physical Activity Index	Number		Mean Serum Cholesterol	
	Above Median*	Below Median*	Above Median*	Below Median*
Men/37-44				
32+	45	20	229	252
< 32	21	32	229	227
Men/45-54				
32+	51	30	231	249
< 32	30	48	234	257
Men/55-59				
32+	34	31	225	234
< 32	23	48	236	241
Women/37-44				
31+	54	26	220	222
< 31	19	22	238	211
Women/45-54				
31+	58	37	242	247
< 31	26	45	244	243
Women/55-69				
31+	24	31	255	250
< 31	24	48	268	272

* Median daily caloric intake: Men = 3124.5; women = 2081.5

Table 11. Regression of serum cholesterol level on Physical Activity Index (PAI), daily caloric intake, and Framingham relative weight (FRW): Framingham Diet Study

Age and sex	Number	Multiple correlation coefficient	Regression coefficients			Correlation of serum cholesterol with		
			PAI	Daily caloric intake	FRW	PAI	Daily caloric intake	FRW
Men								
37-49	196	.237*	.957	-.014*	.730*	.057	-.119	.159
50-59	128	.236	-.346	-.019	.490	-.113	-.214	.061
60-69	84	.139	-.025	-.004	-.376	-.021	-.078	-.124
Women								
37-49	205	.105	-.820	-.005	.124	-.068	-.070	.042
50-59	133	.084	-.231	.006	.014	-.016	.079	.005
60-69	72	.188	-.819	.001	-.673	-.016	.011	-.180

Serum cholesterol = $a + b_1$ PAI + b_2 calories + b_3 FRW

* Significant at 5% level

Table 12. Mean serum cholesterol level according to daily fat intake: Framingham Diet Study

	Number		Mean Serum Cholesterol Level	
Men	Above Median*	Below Median*	Above Median*	Below Median*
37-44	67	61	233	230
45-54	85	81	238	250
55-69	61	76	228	240
Total	213	218	234	241
Women				
37-44	77	53	226	216
45-54	95	80	244	245
55-69	52	85	266	258
Total	224	218	243	243

* Median daily fat intake: Men = 132.000 grams; women = 92.525 grams

Table 13. Mean serum cholesterol level according to daily animal fat intake: Framingham Diet Study

	Number		Mean Serum Cholesterol Level	
Men	Above Median*	Below Median*	Above Median*	Below Median*
37-44	68	60	229	234
45-54	84	82	234	254
55-69	62	75	231	237
Total	214	217	231	243
Women				
37-44	69	61	228	214
45-54	95	80	242	247
55-69	58	79	261	262
Total	222	220	243	243

* Median daily animal fat intake: Men = 95.70 grams; women = 61.64 grams

Table 14. Mean serum cholesterol level according to percent fat from animal sources: Framingham Diet Study

	Number		Mean Serum Cholesterol Level	
Men	Above Median*	Below Median*	Above Median*	Below Median*
37-44	59	69	232	231
45-54	80	86	247	241
55-69	77	60	233	236
Total	216	215	238	236
Women				
37-44	53	77	225	220
45-54	87	88	244	245
55-69	81	56	261	262
Total	221	221	246	240

* Median percent fat from animal sources: Men = 72.3; women = 69.0

NOTE: Percent fat from animal sources is essentially the same statistic as the ratio of plant to animal fat (Table 15).

Table 15. Mean serum cholesterol level according to ratio of intake of plant to animal fat: Framingham Diet Study

	Number		Mean Serum Cholesterol Level	
Men	Above 1:2*	Below 1:2*	Above 1:2*	Below 1:2*
37-44	44	84	229	233
45-54	51	115	240	245
55-69	34	103	229	236
Total	129	302	233	239
Women				
37-44	65	65	218	226
45-54	72	103	242	247
55-69	49	88	262	262
Total	186	256	239	246

* Ratio of intake of plant to animal fat

Table 16. Mean serum cholesterol level according to ratio of complex to simple carbohydrates (C/S ratio) in food intake: Framingham Diet Study

	Number		Mean Serum Cholesterol Level	
Men	Above Median*	Below Median*	Above Median *	Below Median*
37-44	71	57	230	233
45-54	85	81	249	238
55-69	60	77	230	238
Total	216	215	238	237
Women				
37-44	81	49	221	223
45-54	86	89	240	249
55-69	54	83	254	267
Total	221	221	236	250

* Median C/S ratio: Men = 0.925; women = 0.825

Table 17. Mean serum cholesterol level according to daily dietary cholesterol intake: Framingham Diet Study

	Number		Mean Serum Cholesterol Level	
Men	Above Median*	Below Median*	Above Median *	Below Median*
37-44	55	73	233	230
45-54	76	90	242	245
55-69	82	55	235	233
Total	213	218	237	237
Women				
37-44	64	66	216	228
45-54	92	83	247	242
55-69	65	72	258	265
Total	221	221	241	245

* Median dietary cholesterol intake: Men = 670.16 mg; women = 475.22 mg

Table 18. Mean serum cholesterol level according to daily intake of animal fat and dietary cholesterol: Framingham Diet Study

Daily intake of animal fat by sex and age	Number		Mean Serum Cholesterol Level	
	Dietary Cholesterol		Dietary Cholesterol	
	Above Median	Below Median	Above Median	Below Median
Men				
37-49				
A	70	42	233	226
B	26	75	243	240
50-69				
A	77	25	237	220
B	40	76	241	246
Total				
A	147	67	235	224
B	66	151	242	243
Women				
37-49				
A	82	35	223	242
B	26	78	223	228
50-69				
A	83	22	260	255
B	30	86	253	260
Total				
A	165	57	241	247
B	56	164	239	245

A = above median; B = below median

Median daily intake of animal fat: Men = 95.70; women = 61.64 gm.
Median daily intake of dietary cholesterol: Men = 670.16; women = 475.22 mg.

Table 19. Regression of serum cholesterol on daily intake of animal fat and dietary cholesterol: Framingham Diet Study

Age and sex	Number	Multiple correlation coefficient	Regression coefficients for		Correlation of serum cholesterol with	
			animal fat	dietary chol.	animal fat	dietary chol.
Men						
37-49	213	.055	-.041	-.010	-.047	-.053
50-59	132	.070	-.077	-.009	-.065	-.064
60-69	86	.293*	-.306	.069*	-.001	.230*
Women						
37-49	221	.110	.070	-.034	-.040	-.106
50-59	143	.111	.213	-.011	.103	.044
60-69	78	.104	.039	.013	.042	.051

Serum cholesterol = $a + b_1$ animal fat + b_2 dietary cholesterol

* Significant at 5% level

Table 20. Mean of some characteristics of the average daily intake of food by serum cholesterol level: Framingham Diet Study

	Men			Women		
	<180	180-299	300+	<180	180-299	300+
Number of persons	51	329	51	28	369	45
Calories	3181	3166	3009	2132	2149	2087
Protein (grams)						
Total	124	124	125	87	89	86
Animal	92	94	95	65	68	67
Plant	32	30	29	21	20	19
Fat (grams)						
Total	130	138	130	95	96	92
Animal	94	99	94	63	66	64
Plant	36	39	36	32	30	28
Carbohydrate (grams)						
Total	354	324	302	223	229	223
Simple	189	168	153	118	124	127
Complex	166	156	149	106	105	96
Cholesterol (mg)	669	714	676	499	491	484
Iron (mg)	19	19	19	14	14	14
Percent calories from						
Fat	37	39	39	39	40	39
Simple carbohydrate	24	21	20	23	23	25
Complex carbohydrate	21	20	20	19	19	18
Ratio of						
Carbohydrates: complex/simple	0.92	1.00	1.03	0.92	0.91	0.79

Table 21. Regression of specified diet characteristics on serum cholesterol: Framingham Diet Study

Sex and Age	No.	Multiple correlation	Regression Coefficients: Animal protein	Plant protein	Diet chol.	Fat	Carbo-hydrate	C/S ratio	P/S ratio
Men									
37-49	213	.178	.168	-0.568	-.011	.053	-.045	-0.617	57.881
50-59	132	.387*	.703	1.297	-.046	.210	-.388*	-2.775	-35.736
60-69	86	.370	-.255	1.384	.066*	-.050	-.244	-11.874	-31.636
Women									
37-49	221	.206	.464	-0.982	-.037	-.154	.081	-1.889	-12.086
50-59	143	.275	-.217	-1.127	-.005	.475*	-.042	-3.792	32.406
60-69	78	.269	-.508	-2.314	.026	.054	.184	-10.806	1.330

Serum cholesterol = $a + b_1$ animal protein + b_2 plant protein + b_3 dietary cholesterol + b_4 fat intake + b_5 carbohydrate intake + b_6 C/S ratio + b_7 P/S ratio.

* Significant at 5% level

Table 22. Regression of mean weight and weight change on serum cholesterol: Framingham Study

Age at Exam 4 and sex	Number	Multiple correlation coefficient	Regression Coefficients for mean weight	Regression Coefficients for weight change	Correlation of serum cholesterol with mean weight	Correlation of serum cholesterol with weight change
Men						
35-44	654	.156**	.471**	.471*	.142**	.052
45-54	673	.168**	.389**	.717**	.128**	.107**
55-64	619	.061	-.055	.398	-.020	.059
Women						
35-44	759	.130**	.269**	.387**	.106**	.076*
45-54	796	.054	.122	.151	.046	.029
55-64	769	.118**	-.051	.604**	-.022	.116**

Serum cholesterol = $a + b_1$ mean weight + b_2 weight change

Note: Mean weight is the average Framingham relative weight for Exams 1-4. Weight change is Framingham relative weight at Exam 4 minus Framingham relative weight at Exam 1. Serum cholesterol measured at Exam 4. Exam 4 came six years after Exam 1.

* Significant at 5% level.
** Significant at 1% level.

Table 23. Mean daily iron intake at specified levels of blood hemoglobin: Framingham Diet Study

Sex and age	Number with hemoglobin level of						Mean daily iron intake at hemoglobin levels of					
	Total	< 10.0	10.0-13.4	13.5-14.4	14.5-15.9	16.0+	Total	< 10.0	10.0-13.4	13.5-14.4	14.5-15.9	16.0+
Men												
37-49	210	0	11	47	124	28	19.2	---	18.2	20.2	19.1	18.1
50-59	132	0	12	28	79	13	18.8	---	18.1	19.9	18.5	18.2
60-69	84	0	12	25	41	6	18.2	---	20.0	17.0	18.2	19.9
Total	426	0	35	100	244	47	18.8	---	18.8	19.3	18.8	18.4
Women												
37-49	222	6	115	78	21	2	14.0	15.2	14.0	14.0	13.2	12.7
50-59	143	0	69	51	23	0	13.8	---	14.1	13.6	13.6	---
60-69	76	1	41	18	14	2	13.7	12.3	14.4	13.0	12.8	14.0
Total	441	7	225	147	58	4	13.9	14.8	14.1	13.8	13.3	13.3

NOTE: Hemoglobin is expressed as gm/100 ml

Table 24. Mean values for specified nutrient measurements for persons who developed CHD subsequent to their diet interviews, by sex: Framingham Diet Study

	Men		Women	
	Actual	Expected[1]	Actual	Expected[1]
Number of cases	32	380	15	419
Calories	3144.1	3127.9	2162.7	2087.8
Protein (grams)				
Total	127.0	124.2	90.0	86.8
Animal	96.3	94.7	70.7	66.9
Plant	30.7	29.5	19.3	19.8
Fat (grams)				
Total	140.4	135.2	98.5	92.2
Animal	102.1	98.0	70.3	63.4
Plant	38.2	37.2	28.2	28.8
Carbohydrate (grams)				
Total	321.8	320.2	224.0	224.3
Simple	162.5	154.0	97.0	101.2
Complex	159.3	166.3	127.0	123.1
Cholesterol (grams)	708.3	716.1	519.9	477.5
Iron (milligrams)	19.4	18.8	14.2	13.7
Percent				
Calories from fat	39.8	38.9	40.6	39.3
Fat from animal sources	72.5	72.4	71.9	69.2
Calories from simple CHO	20.3	21.1	23.4	23.8
Calories from complex CHO	20.7	19.7	17.6	19.2
CHO from complex sources	50.9	48.3	43.4	45.0
C/S ratio	1.1	1.0	0.9	0.9
Framingham relative weight (%)	104.5	102.0	99.8	101.3
Systolic blood pressure (mm Hg)	135.1	131.2	139.3	134.0
Serum cholesterol (mg%)	270.8	240.7	249.6	248.2
Physical Activity Index	33.8	33.8	30.2	31.2

1 Age-specific means for total group adjusted to age-distribution of CHD cases. No CHD cases appeared outside the age range 40-64 years.

FIGURES

Figure 1

MEAN VALUE OF AVERAGE DAILY CALORIC INTAKE FOR EACH THREE-MONTH PERIOD: FRAMINGHAM DIET STUDY, MEN, JANUARY 1957 TO SEPTEMBER 1960

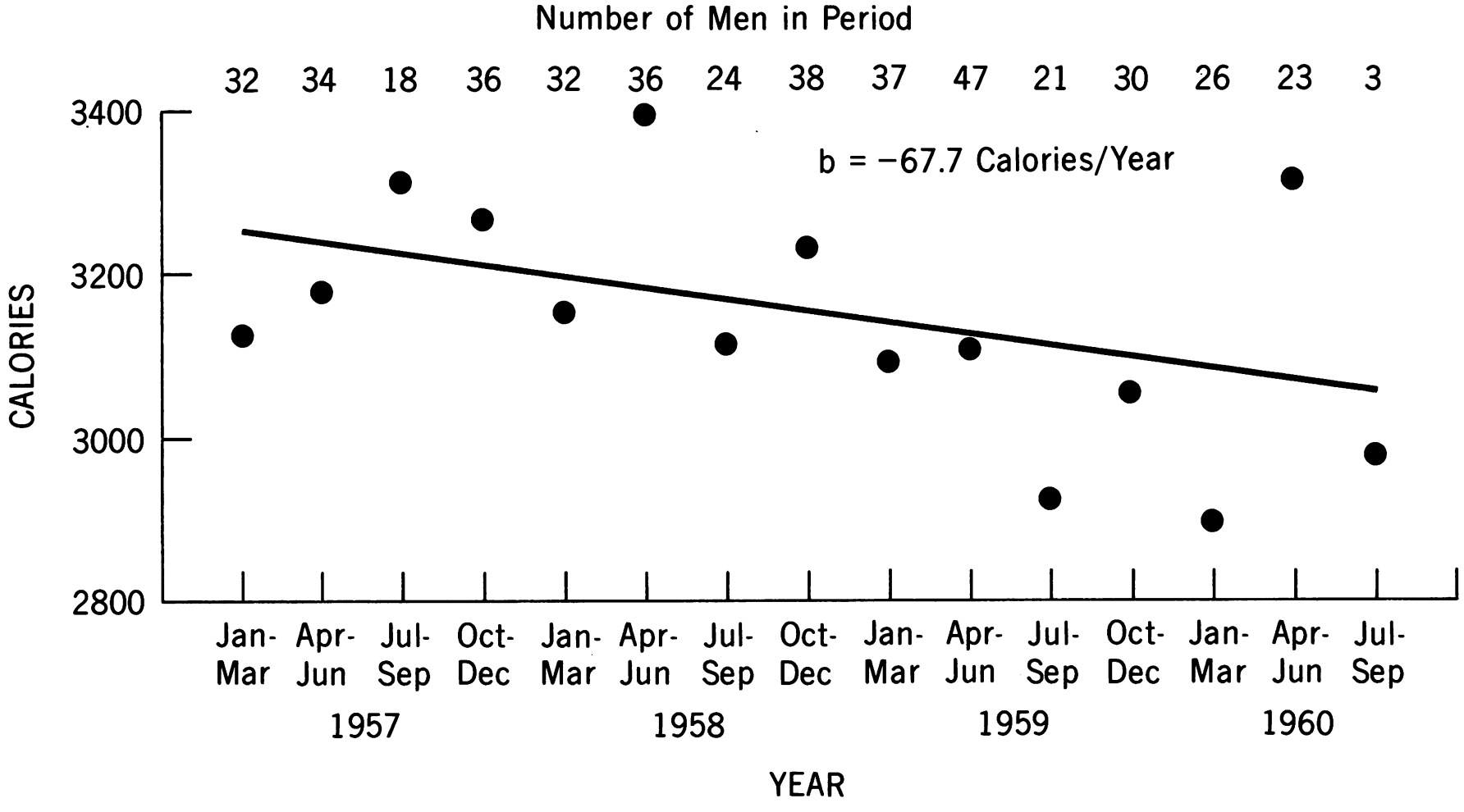


Figure 4

MEAN VALUE OF AVERAGE DAILY FAT INTAKE FOR EACH THREE-MONTH PERIOD: FRAMINGHAM DIET STUDY, WOMEN, JANUARY 1957 TO SEPTEMBER 1960

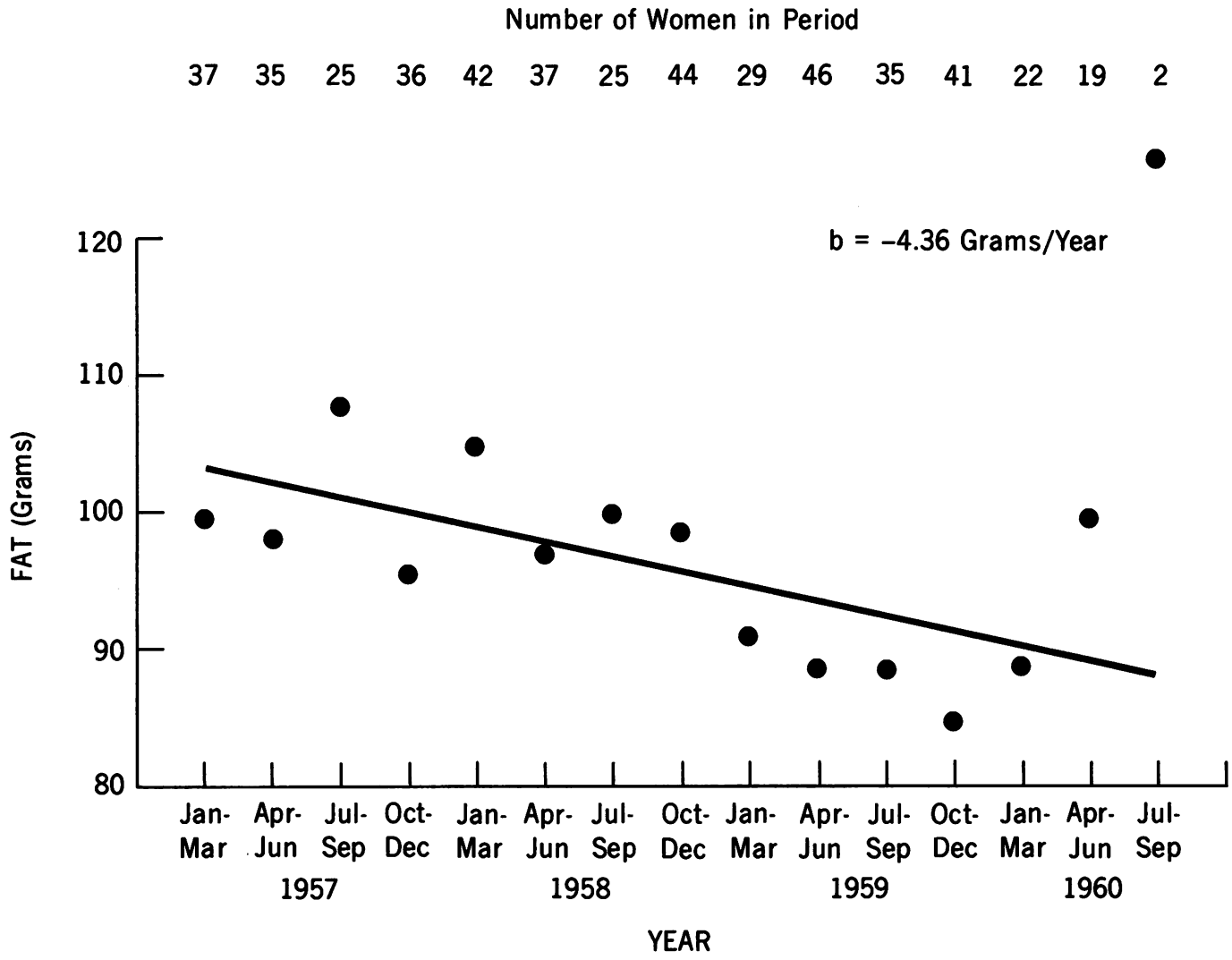


Figure 5

MEAN VALUE OF BODY WEIGHT FOR EACH THREE-MONTH PERIOD: FRAMINGHAM DIET STUDY, MEN, JANUARY 1957 TO SEPTEMBER 1960

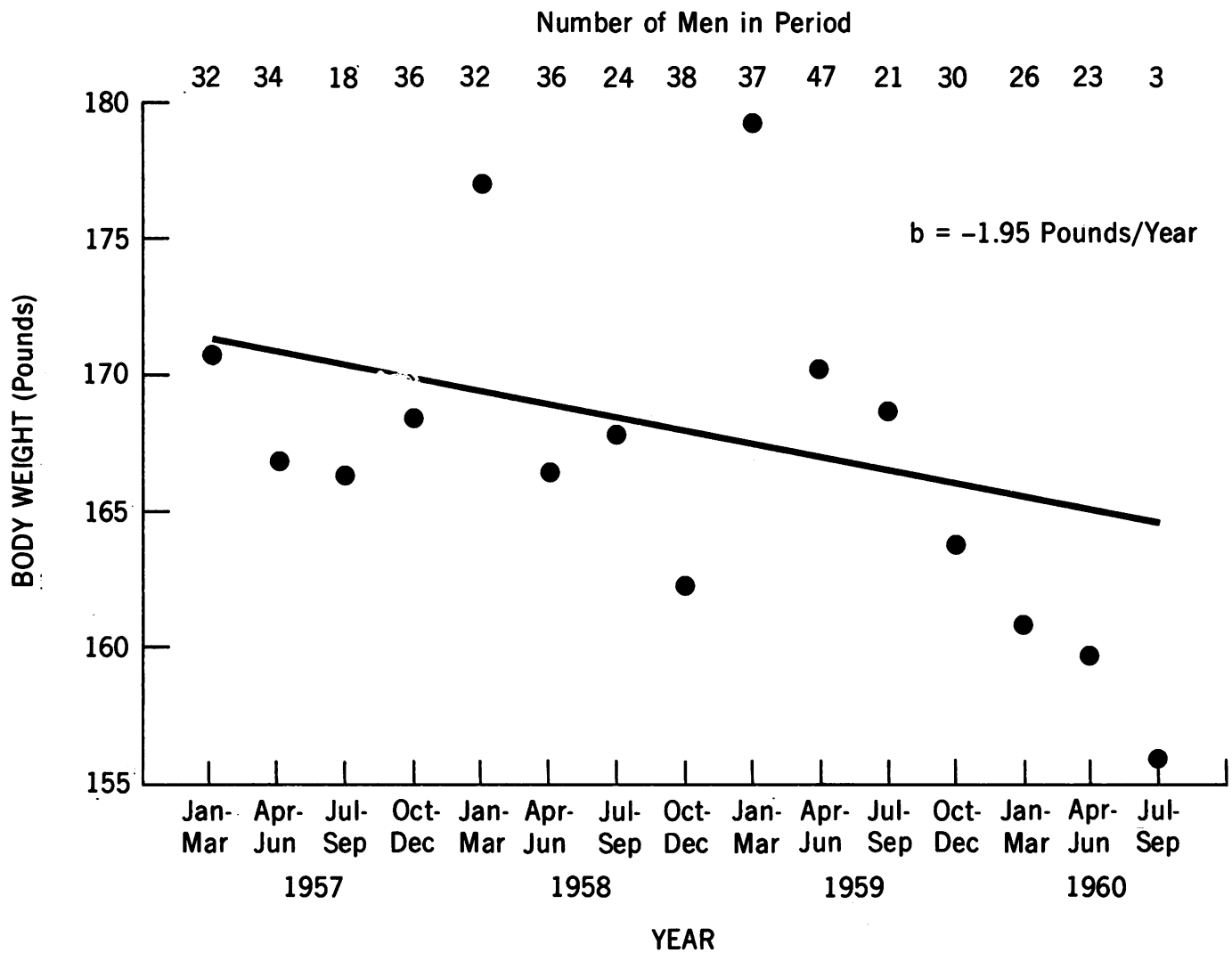


Figure 6

MEAN VALUE OF BODY WEIGHT FOR EACH THREE-MONTH PERIOD: FRAMINGHAM DIET STUDY, WOMEN, JANUARY 1957 TO SEPTEMBER 1960

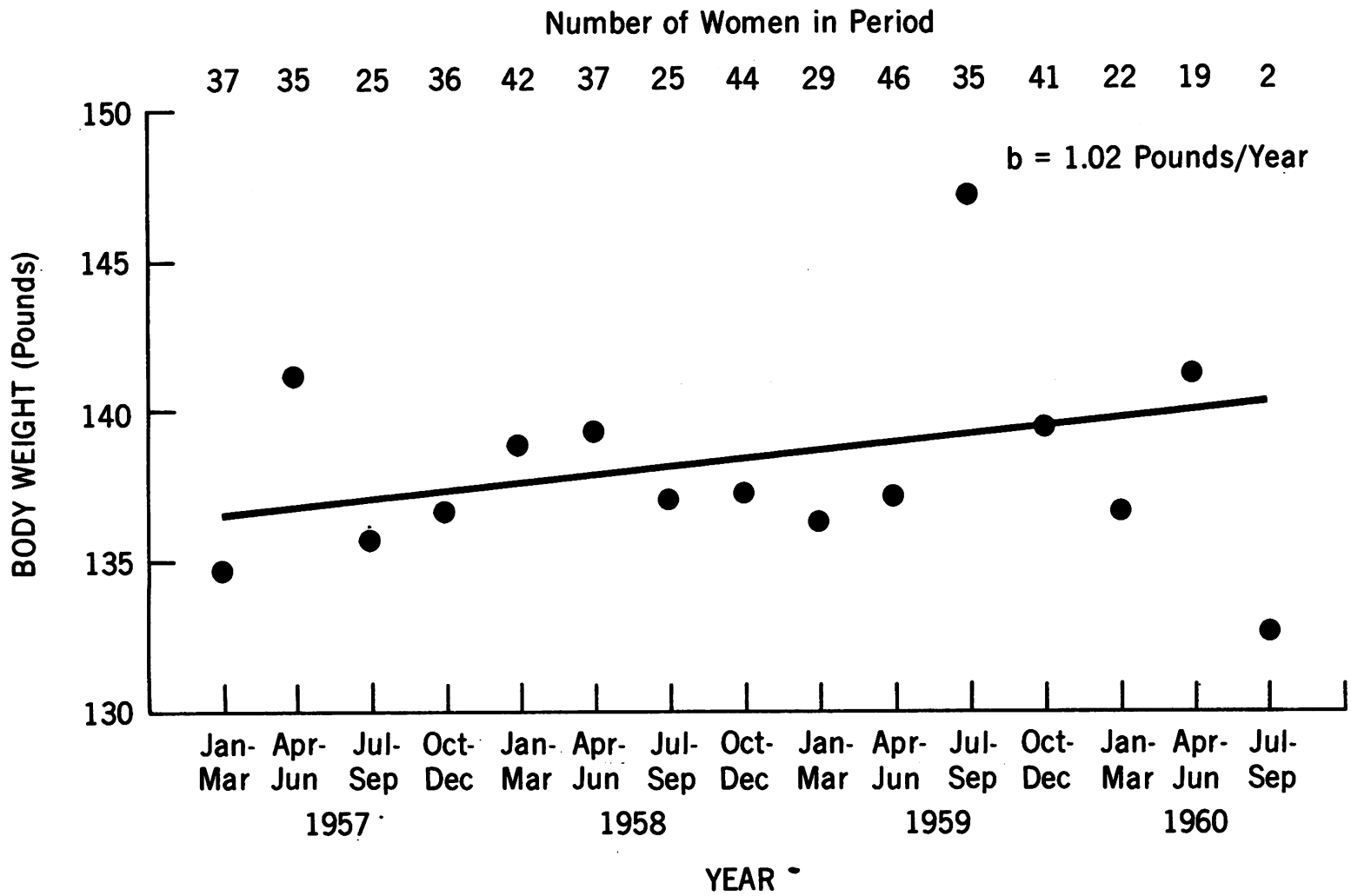


Figure 7
CALORIES IN DAILY INTAKE:
FRAMINGHAM DIET STUDY

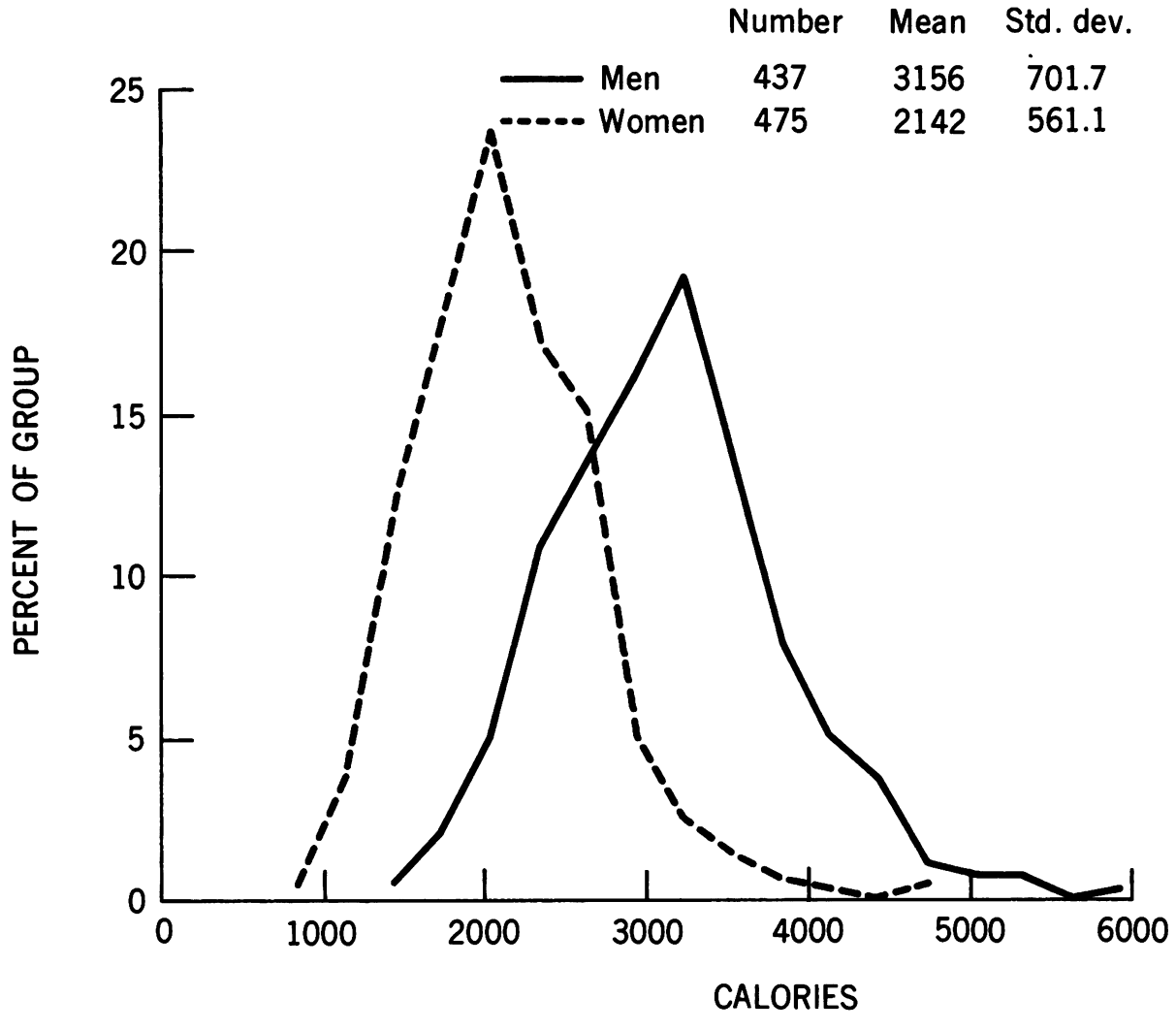


Figure 8
CALORIES IN DAILY INTAKE PER POUND PER BODY WEIGHT: FRAMINGHAM DIET STUDY

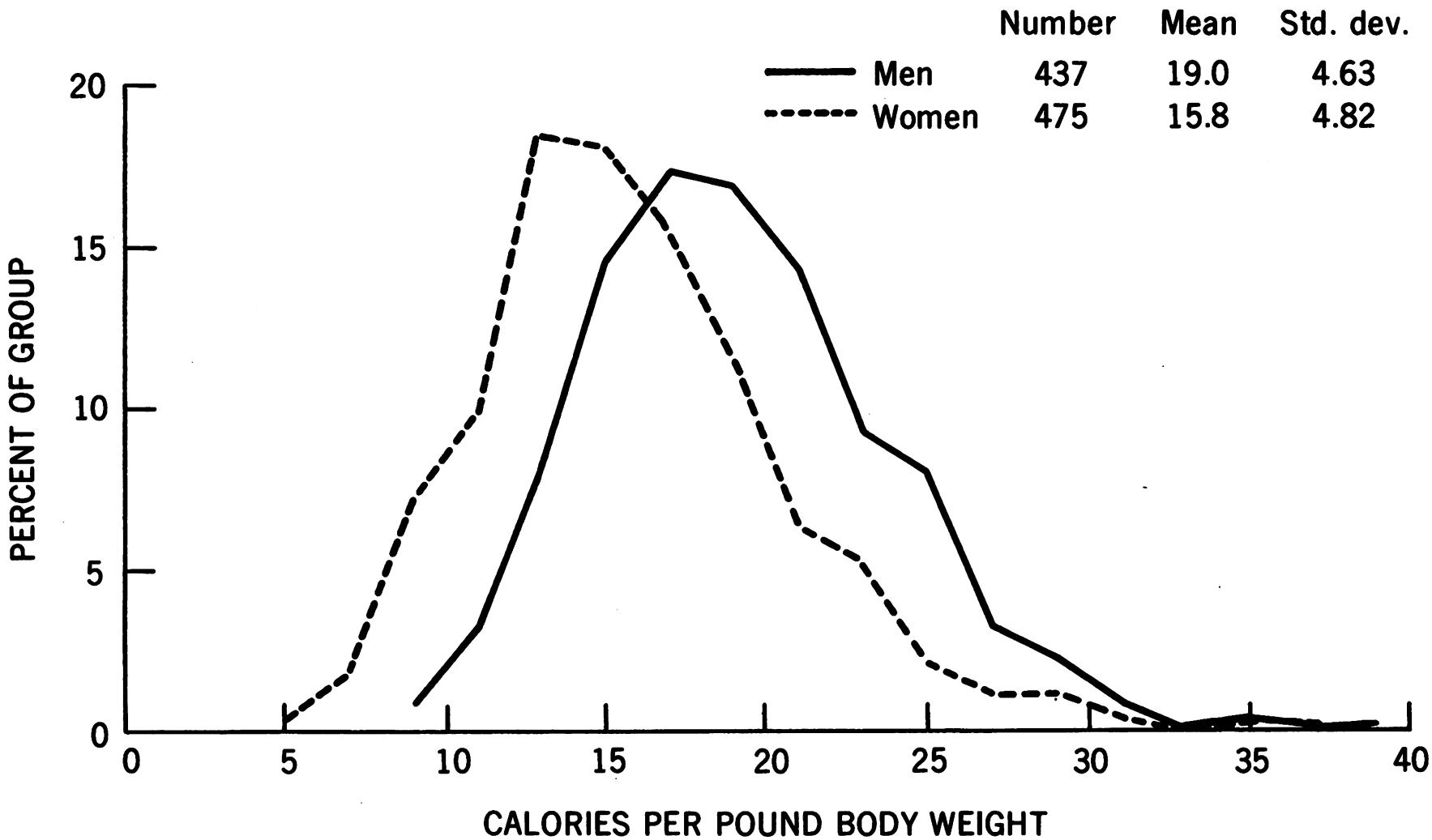


Figure 9

PROTEIN IN DAILY INTAKE: FRAMINGHAM DIET STUDY

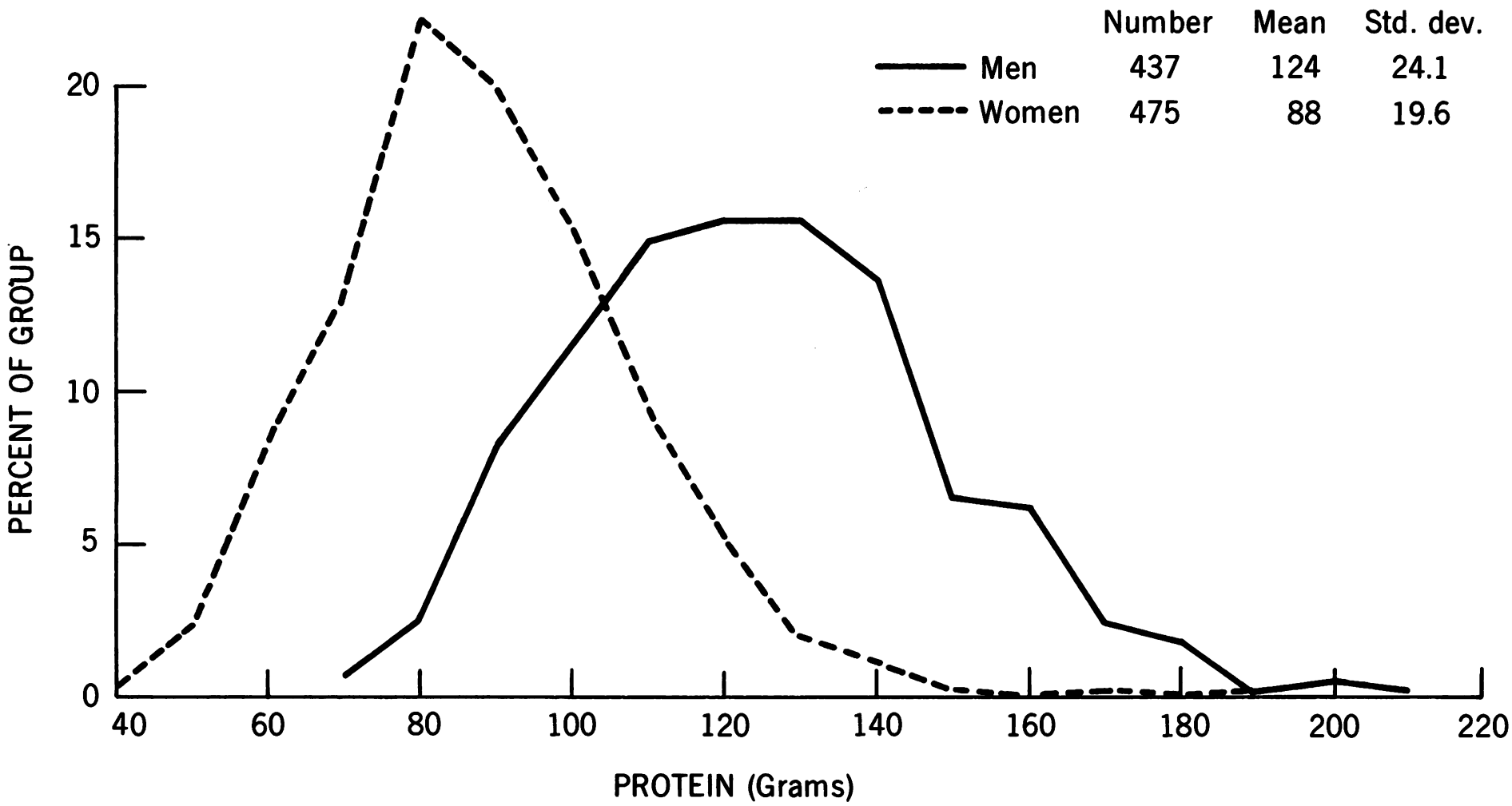


Figure 10

ANIMAL PROTEIN IN DAILY INTAKE: FRAMINGHAM DIET STUDY

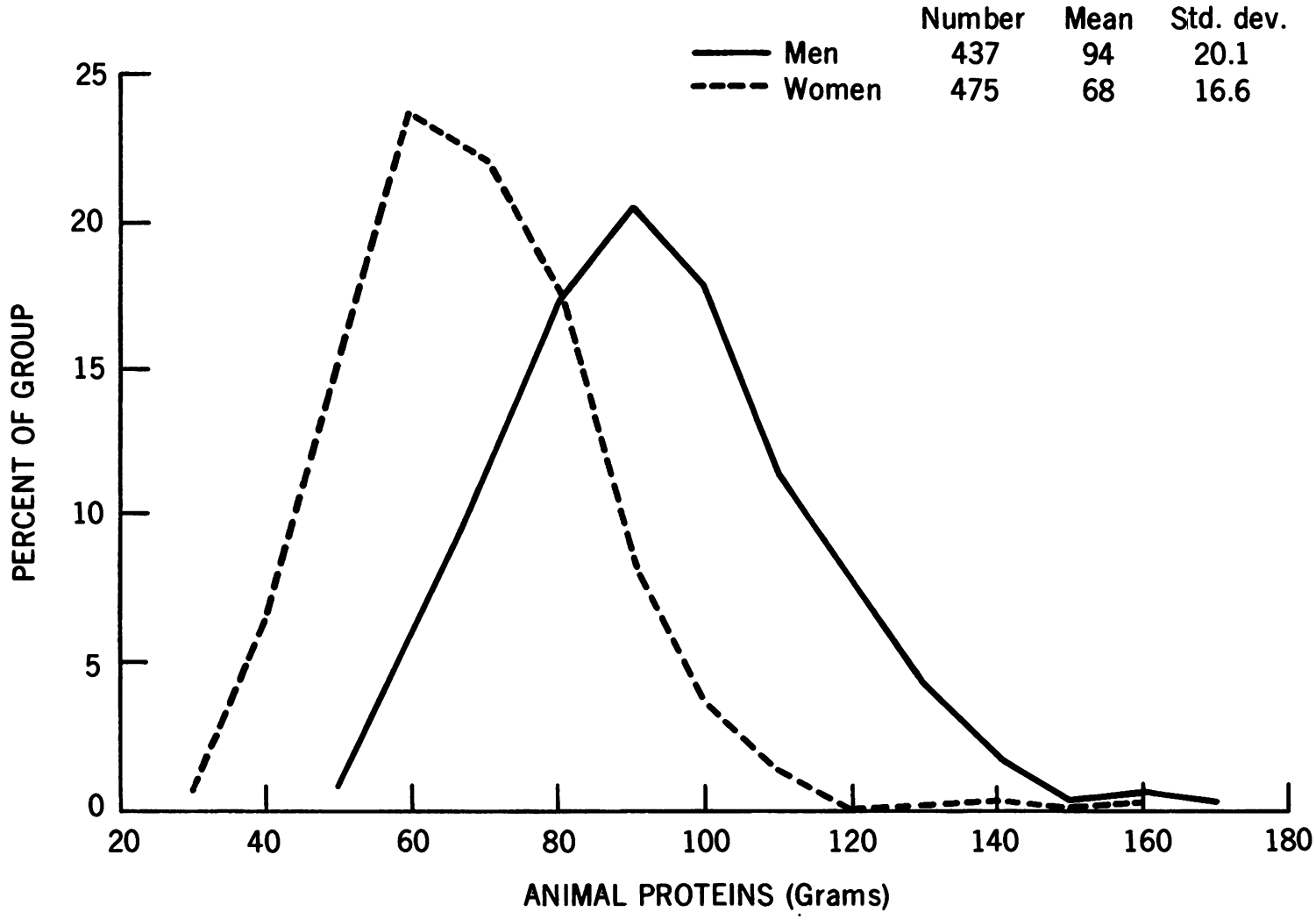


Figure 11

PLANT PROTEIN IN DAILY INTAKE: FRAMINGHAM DIET STUDY

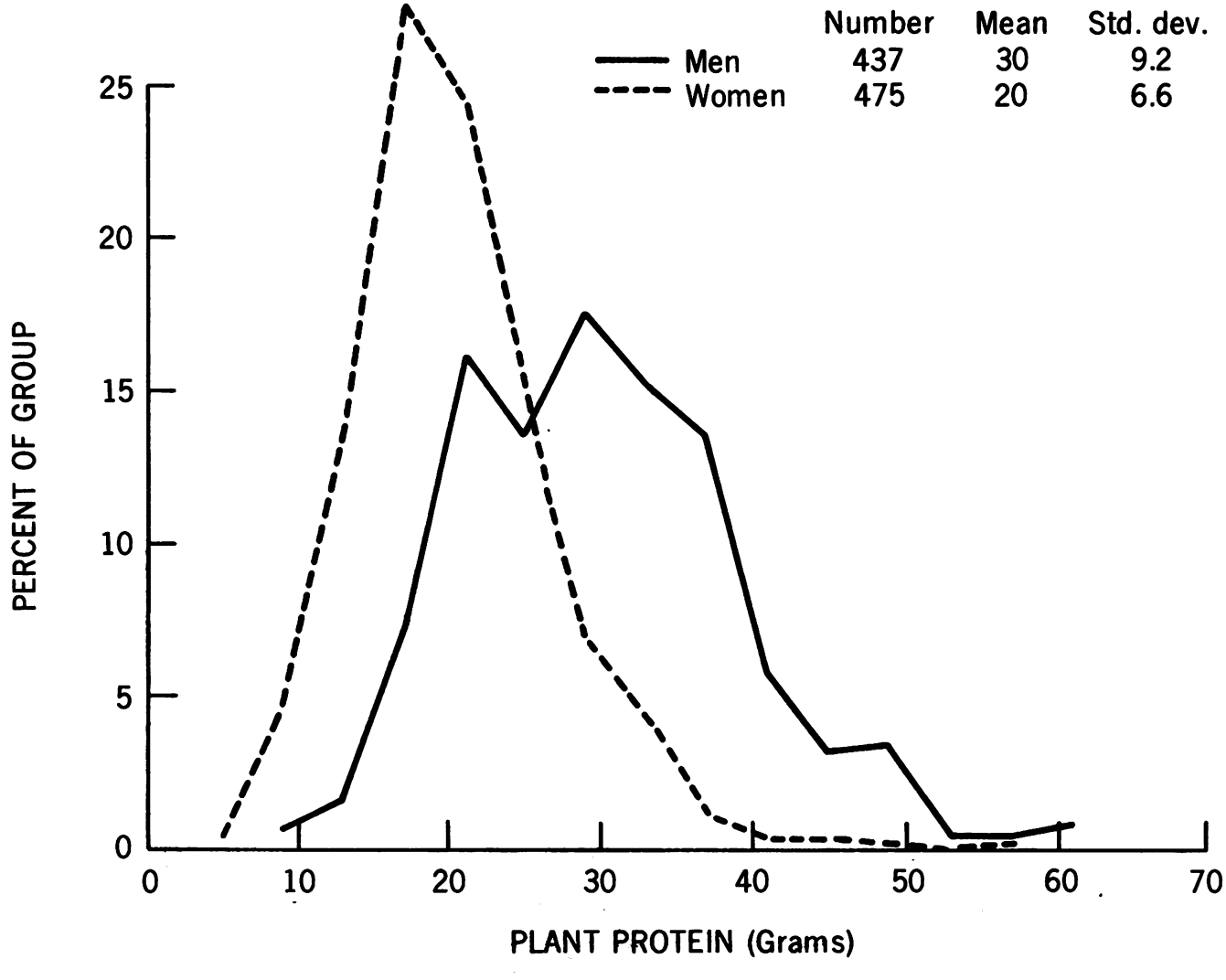


Figure 12

FAT IN DAILY INTAKE: FRAMINGHAM DIET STUDY

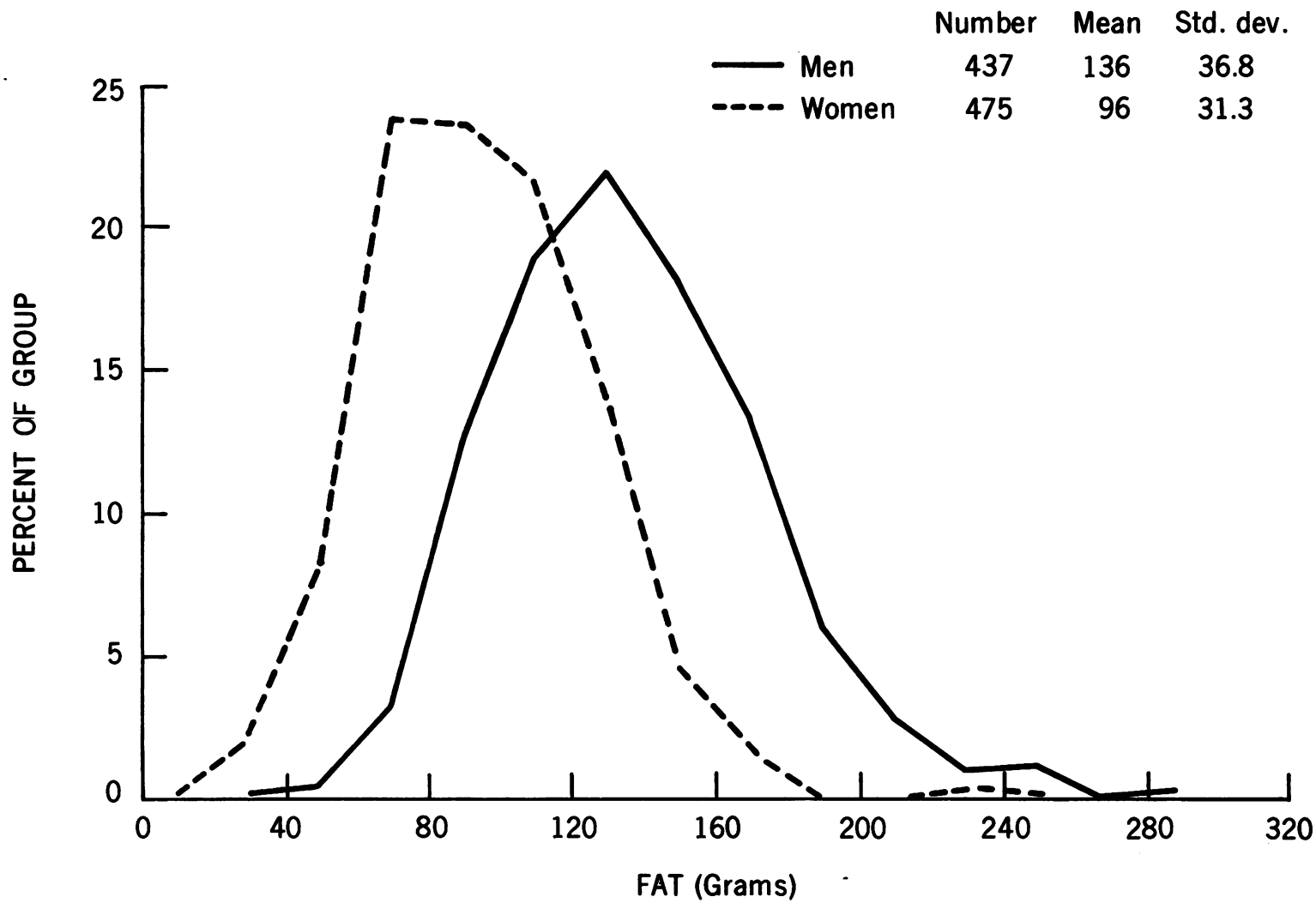


Figure 13

FAT IN DAILY INTAKE PER POUND BODY WEIGHT: FRAMINGHAM DIET STUDY

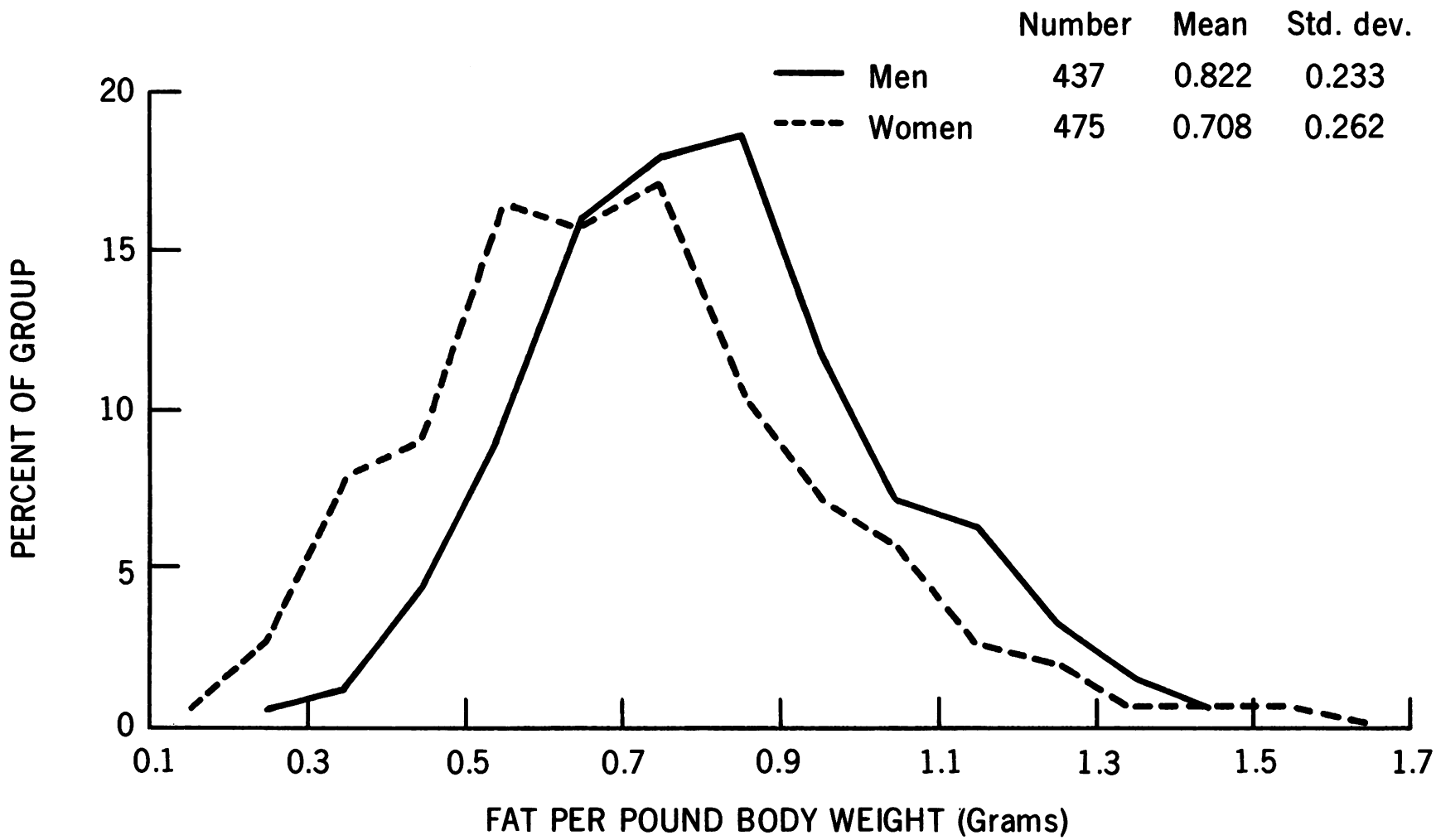


Figure 14

ANIMAL FAT IN DAILY INTAKE: FRAMINGHAM DIET STUDY

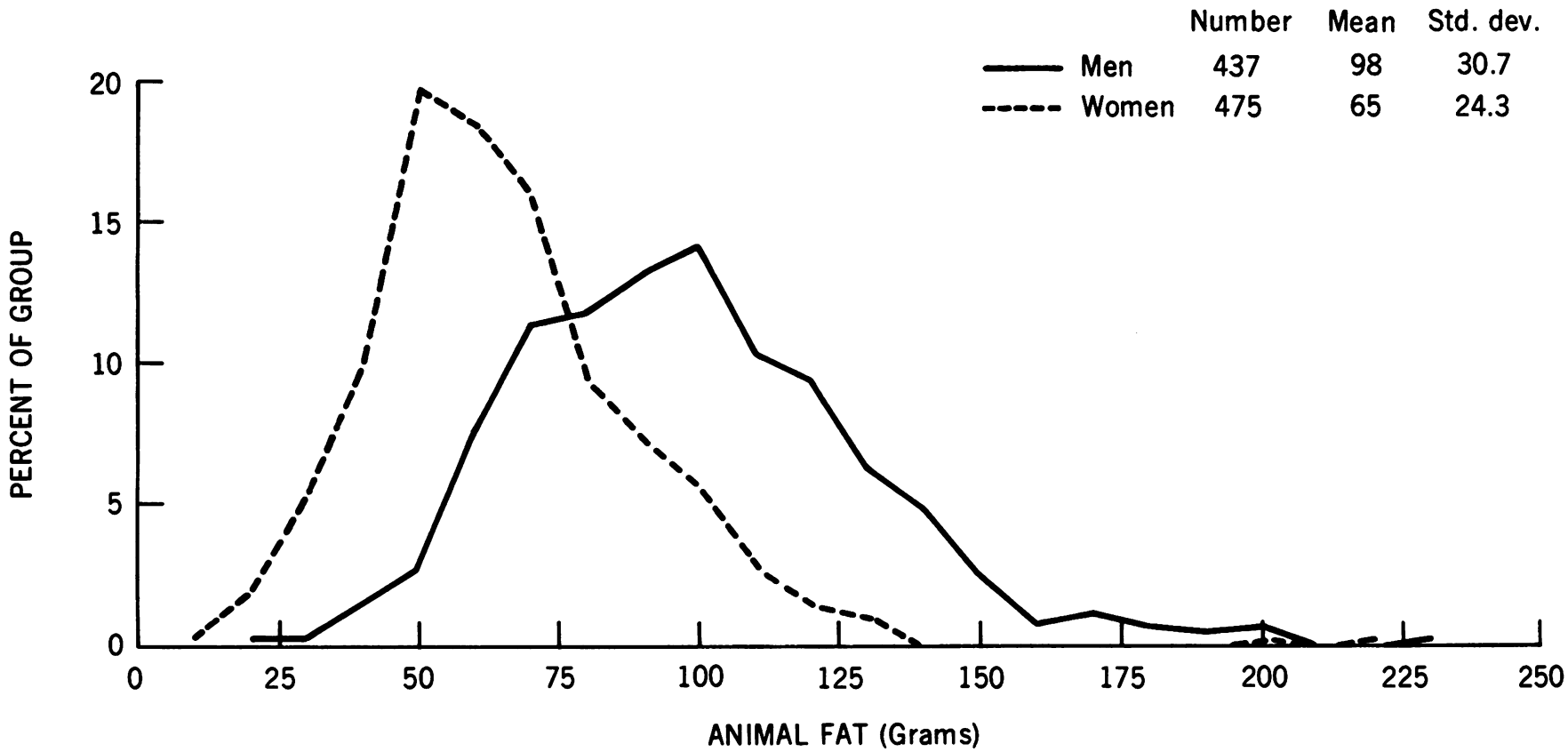


Figure 15

PLANT FAT IN DAILY INTAKE:
FRAMINGHAM DIET STUDY

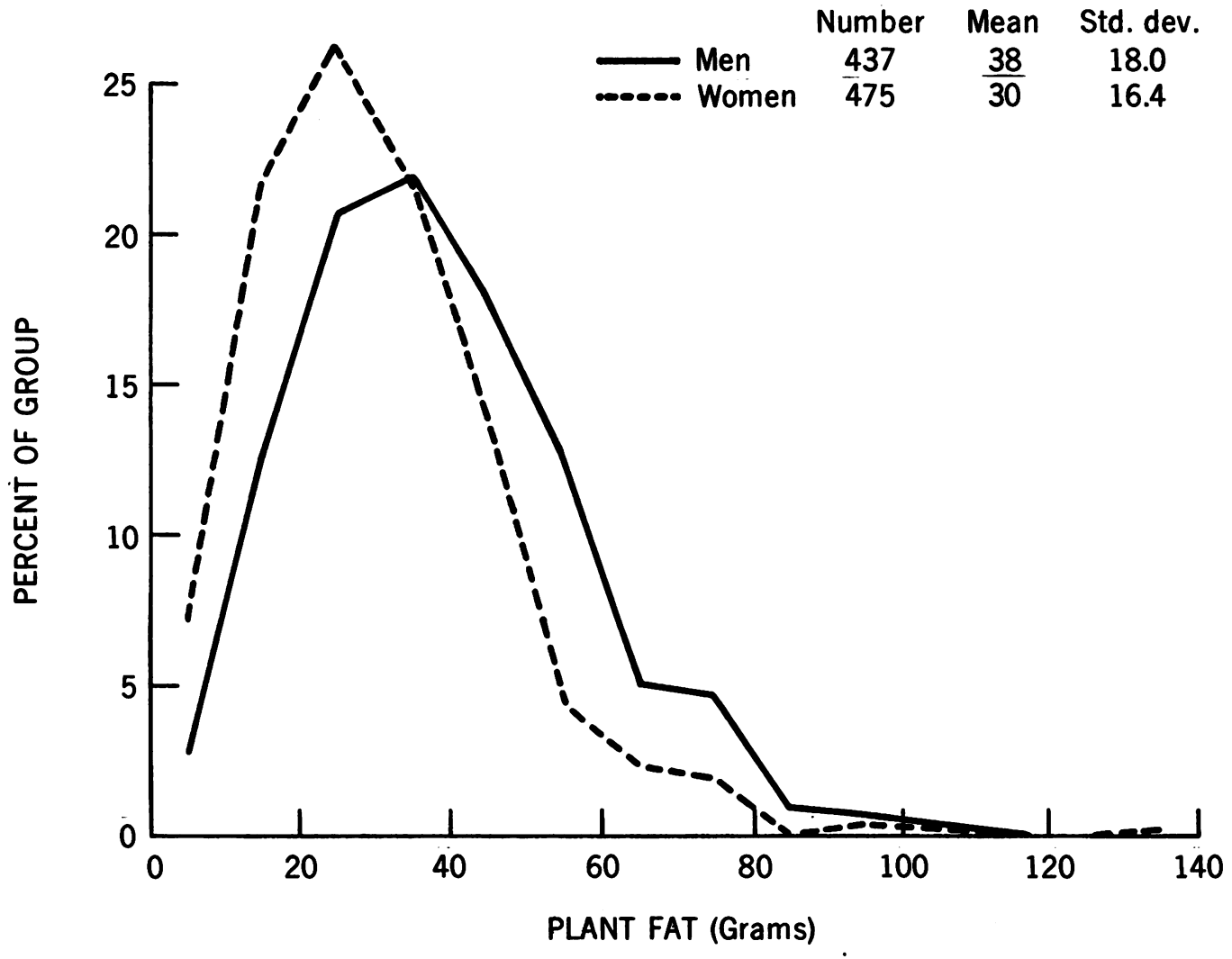


Figure 16

PERCENT CALORIES FROM FAT: FRAMINGHAM DIET STUDY

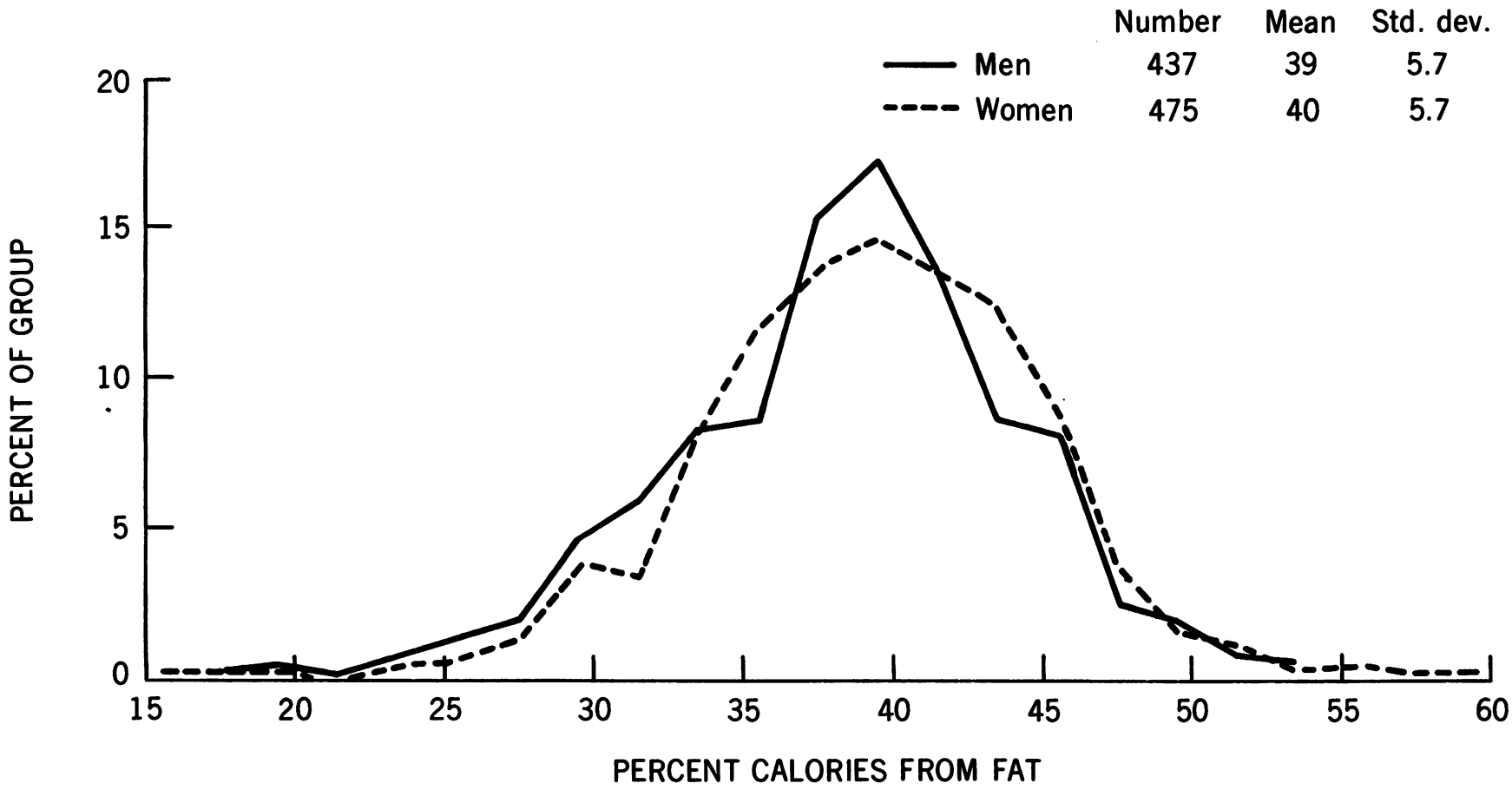


Figure 17

PERCENT FAT FROM ANIMAL SOURCES: FRAMINGHAM DIET STUDY

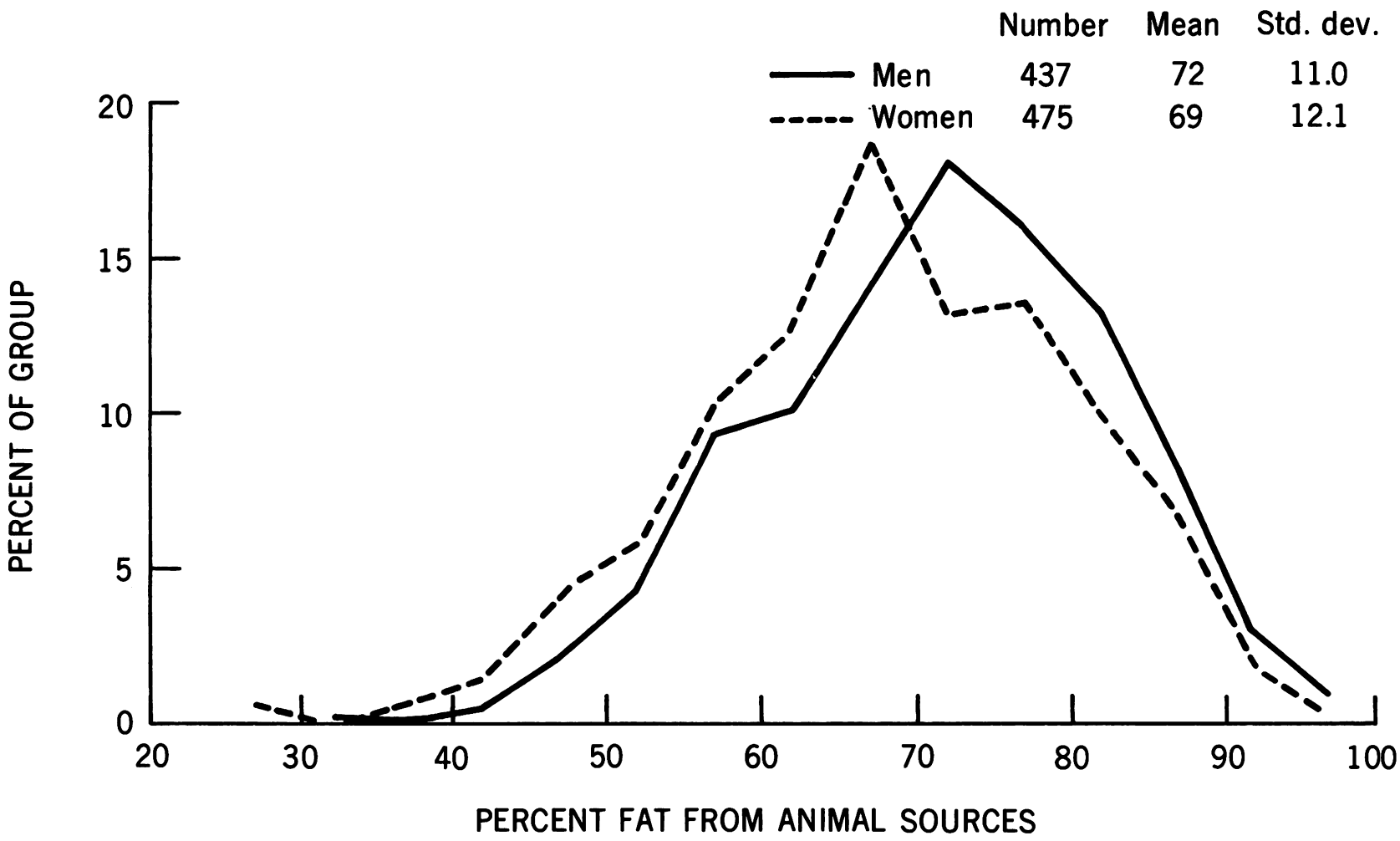


Figure 18

RATIO POLYUNSATURATED FATTY ACID TO SATURATED FATTY ACID IN DAILY INTAKE: FRAMINGHAM DIET STUDY

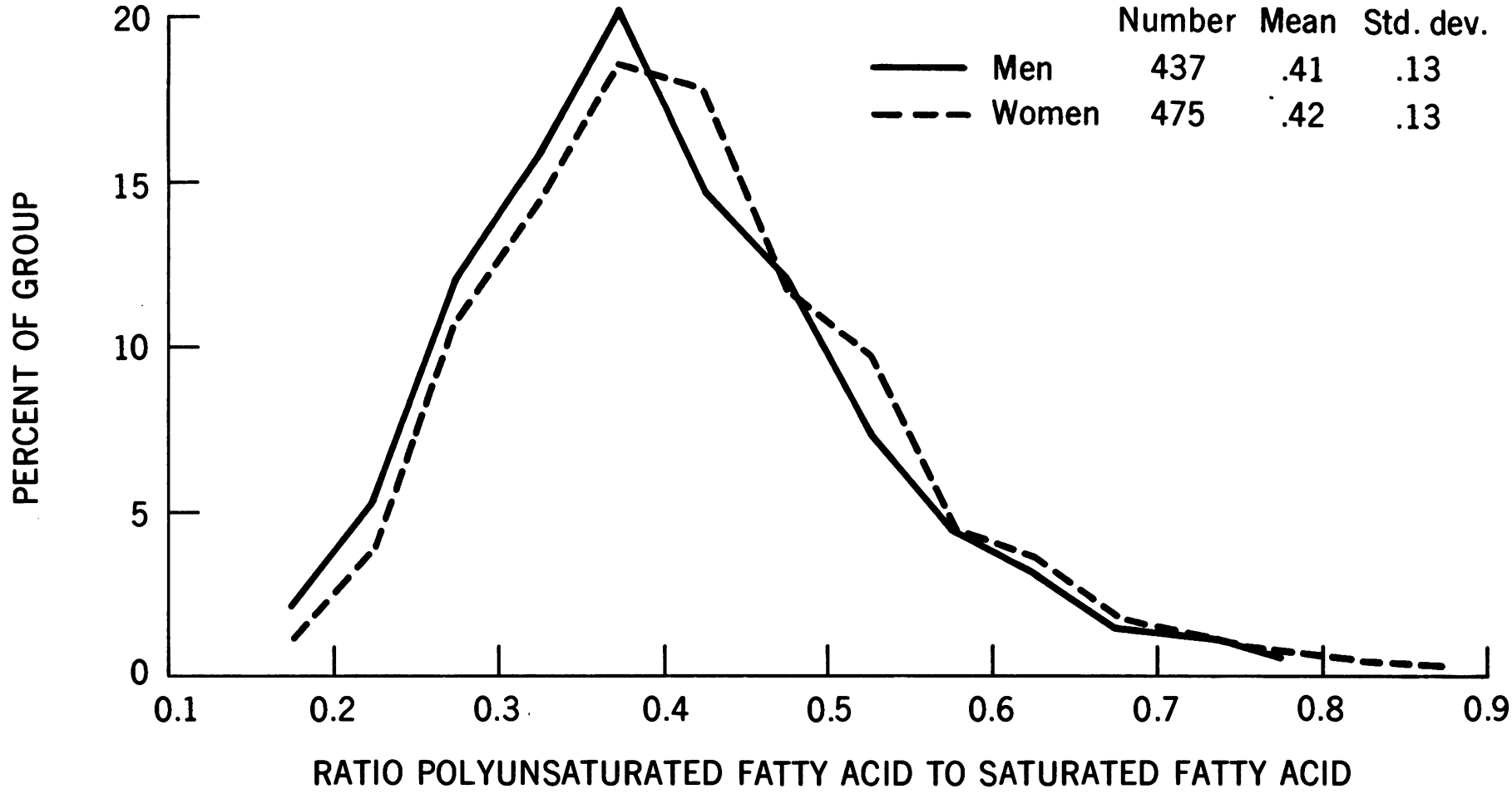


Figure 19

IRON IN DAILY INTAKE:
FRAMINGHAM DIET STUDY

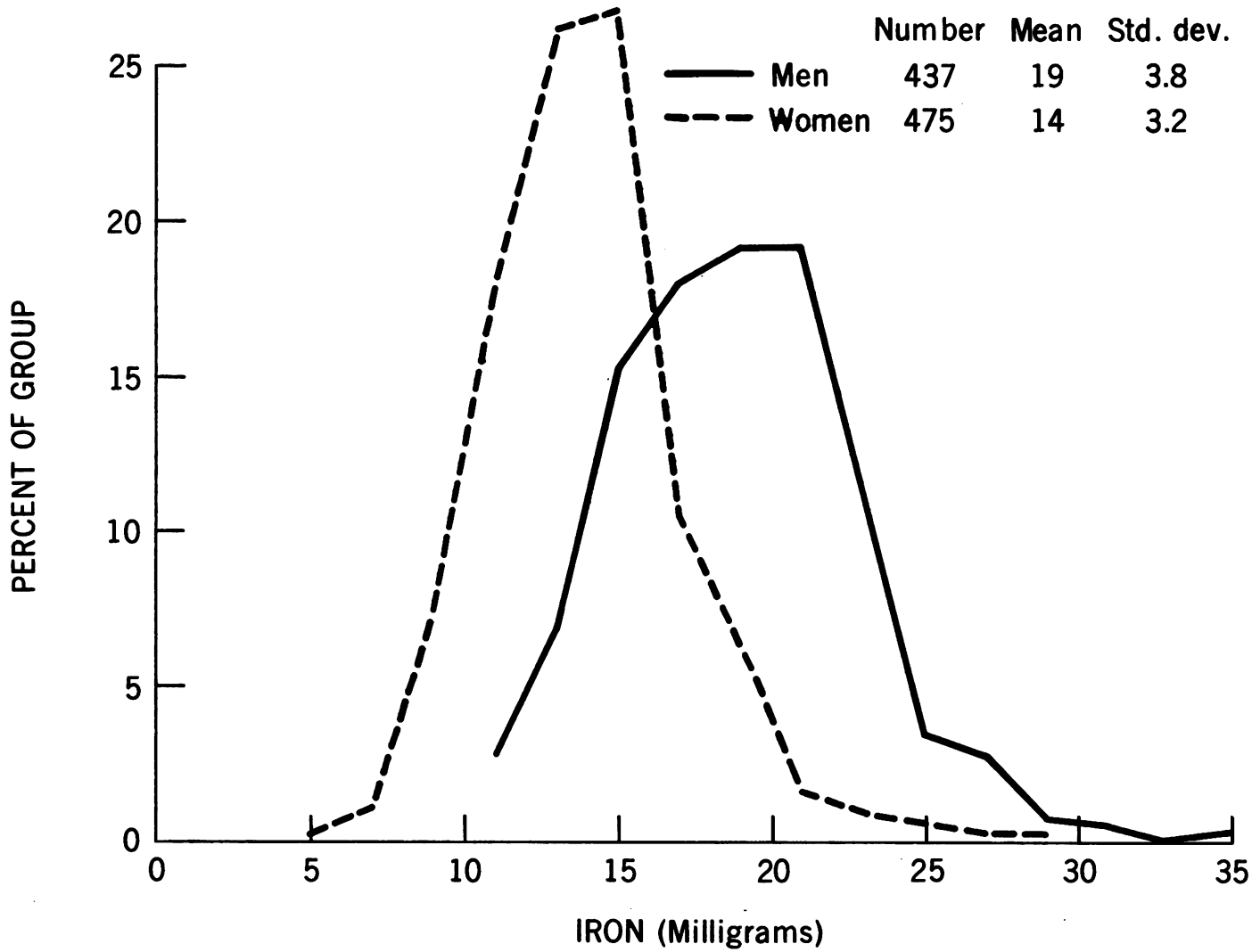
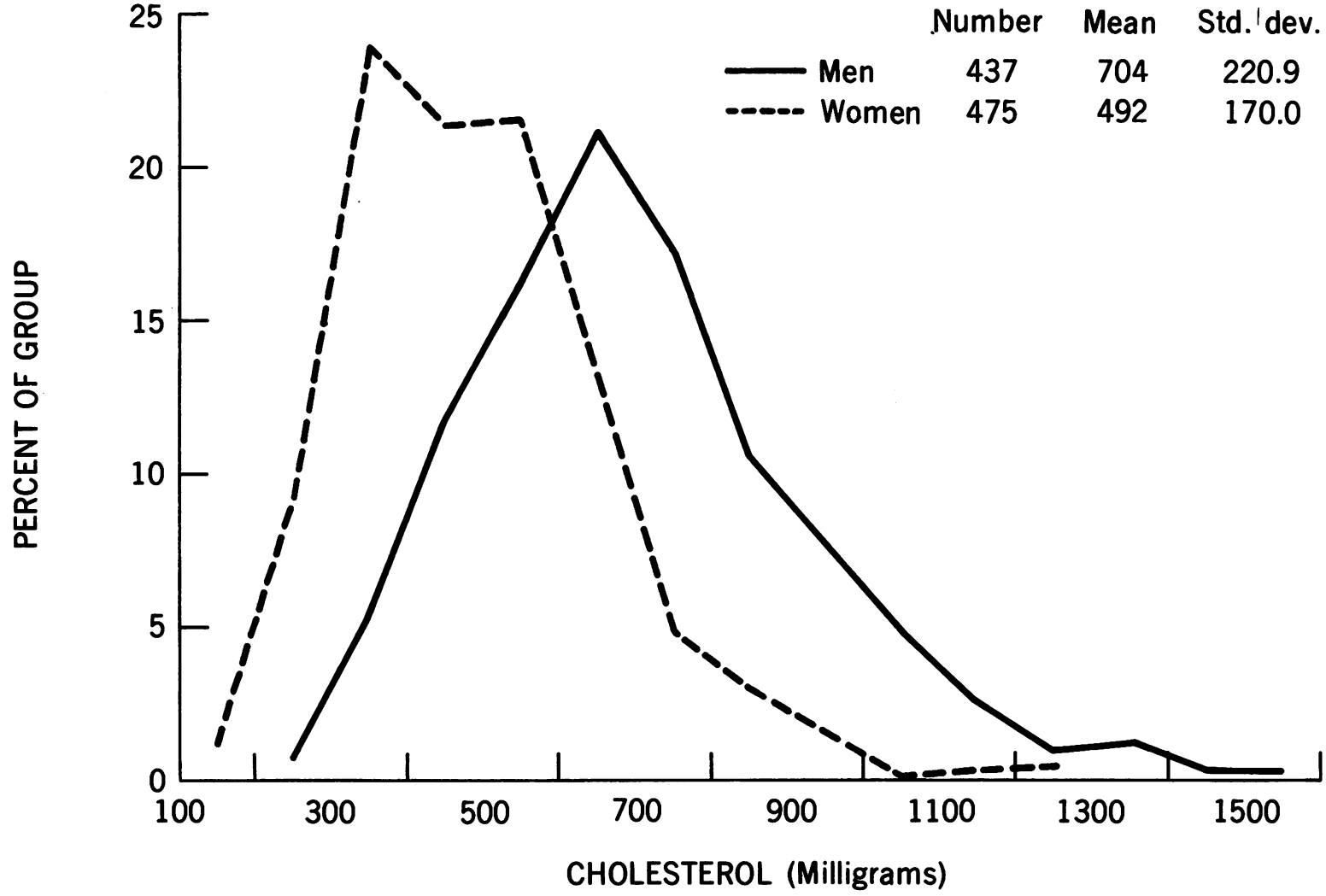


Figure 20
CHOLESTEROL IN DAILY INTAKE: FRAMINGHAM DIET STUDY



APPENDIX

Throughout this paper the data have been treated as if they derived from a simple random sample. However, the sampling scheme involved several constraints which have to be considered, since they are bound to introduce some bias into the estimates of regression (or correlation) made for this paper (unpublished notes by Max Halperin).

In all likelihood the extent of the induced bias is small. However, it is worth restricting at least one key table to data from the random sample to reassure the reader on this point. The table that is reproduced is Table 6.

If the correlations between various diet characteristics and serum cholesterol are examined separately for the random sample and the supplementary groups, the following appears to be the case:

In men the correlations appear to be smaller for the random sample than the supplementary group. Since the supplementary group of men were those with either high or low cholesterol values at their initial determination the effect of this type of selection does appear to be (as anticipated) an upward bias. The supplementary group of women were chosen not on the basis of their own characteristics but on the basis of their spouses' characteristics. Hence it is difficult to guess how they might differ from the random sample. What differences are evident in the correlations appear to be of a random nature.

The generally negative conclusions in the report are only reinforced by these facts.

Appendix Table. Correlation of serum cholesterol with some characteristics of the average daily intake of food by age and sex: Framingham Diet Study (RANDOM SAMPLE ONLY).

Characteristic	Men			Women		
	37-49	50-55	60-69	37-49	50-59	60-69
Number of persons	139	94	66	89	59	48
Calories	-.01	-.15	-.03	.001	.04	.04
Calories per body weight	-.12	-.12	-.01	-.01	.06	.12
Protein						
Total	.04	-.05	.10	-.08	-.06	-.25
Animal	.06	-.04	.15	-.07	-.05	-.25
Plant	-.01	-.06	-.09	-.05	-.08	-.09
Fat						
Total	-.04	-.05	.01	-.02	.14	-.04
Animal	-.01	-.06	.05	.02	.11	-.10
Plant	-.06	.01	-.08	-.10	.11	.11
Carbohydrate						
Total	-.08	-.27	-.11	.06	-.08	.14
Simple	-.10	-.25	-.07	.08	-.05	.22
Complex	-.04	-.18	-.11	.01	-.09	.02
Cholesterol	.04	-.08	.19	-.07	-.12	-.18
Iron	.03	-.06	-.001	-.10	-.07	-.26
Percent calories from						
Fat	-.04	.12	-.01	-.07	.30	-.14
Simple carbohydrate	-.11	-.22	-.07	.14	-.15	.31
Complex carbohydrate	-.07	-.11	-.10	.04	-.20	-.05
Percent fat from animal sources	.05	-.02	.10	.11	-.06	-.16
Ratio of						
Fatty acids: polyunsaturated/saturated	.03	-.06	-.18	-.23	.06	.10
Carbohydrates: complex/simple	.05	.04	.02	-.05	-.06	-.17

Appendix Table. Correlation of serum cholesterol with some characteristics of the average daily intake of food by age and sex: Framingham Diet Study (SUPPLEMENTARY GROUPS).

Characteristic	37-49	50-59	60-69	37-49	50-59	60-69
Number of persons	74	38	20	132	84	30
Calories	-.20	-.27	-.19	-.10	.06	.08
Calories per body weight	-.24	-.32	-.04	-.15	.03	.14
Protein						
Total	-.15	-.09	-.18	-.003	-.002	.17
Animal	-.07	.05	-.11	.07	-.00	.25
Plant	-.20	-.33	-.30	-.16	.02	-.12
Fat						
Total	-.09	-.17	-.07	-.16	.15	.20
Animal	-.11	-.09	-.10	-.10	.09	.31
Plant	-.02	-.22	.02	-.17	.13	-.11
Carbohydrate						
Total	-.18	-.38	-.46	-.13	-.01	-.07
Simple	-.15	-.38	-.28	-.04	-.05	.02
Complex	-.16	-.30	-.46	-.20	.05	-.17
Cholesterol	-.16	-.06	.34	-.13	.20	.42
Iron	-.18	-.08	-.12	-.08	.07	.24
Percent calories from						
Fat	.08	.16	.12	-.20	.23	.26
Simple carbohydrate	-.01	-.40	-.26	.07	-.13	-.11
Complex carbohydrate	-.04	-.17	-.50	-.23	.01	-.28
Percent fat from animal sources	-.09	.12	-.11	.08	-.07	.23
Ratio of						
Fatty acids: polyunsaturated/saturated	.19	.01	.14	.11	.07	-.27
Carbohydrates: complex/simple	-.01	.13	-.03	-.11	.08	-.19

PREVIOUS SECTIONS

PREVIOUS SECTIONS

Section 1. Introduction and general background
Tavia Gordon and William B. Kannel

Section 2. Follow-up to the eighth examination
Tavia Gordon

Section 3. Some characteristics of the Framingham cohort on the first 7 examinations by broad age groups
Christine Cole, Esther Allen, Manning Feinleib

Notes: Dewey Shurtleff, William P. Castelli, Lloyd E. Hawes, and Patricia M. McNamara

Section 4. Some characteristics of the Framingham cohort on the first 7 examinations by 5-year age groups
Dewey Shurtleff

Section 5. Bivariate correlations among some characteristics of the Framingham cohort at Exam 2
Dewey Shurtleff

Section 6. Smoothed average annual incidence rates by age at exam preceding event, and sex
Manning Feinleib

Section 7. Average two-year incidence rates by age at exam preceding event and sex, with total number of events and total population at risk
Manning Feinleib

Section 8. Two-year incidence by exam interval by age at Exam 1 and sex
Manning Feinleib

Criteria: William B. Kannel, William P. Castelli, and Patricia M. McNamara

Section 9. Population alive with specified events by sex, age and level of characteristic at exam
Dewey Shurtleff

Section 10. Incidence of Coronary Heart Disease by sex, age and level of characteristic at exam for 22 characteristics
Dewey Shurtleff

PREVIOUS SECTIONS

Section 11. Incidence of Myocardial Infarction by sex, age and level of characteristic at exam for 22 characteristics
Dewey Shurtleff

Section 12. Incidence of Angina Pectoris uncomplicated by sex, age and level of characteristic at exam for 22 characteristics
Dewey Shurtleff

Section 13. Incidence of Sudden Death from Coronary Heart Disease by sex, age and level of characteristic at exam for 22 characteristics
Dewey Shurtleff

Section 14. Incidence of Non-Sudden Death from Coronary Heart Disease by sex, age and level of characteristic at exam for 22 characteristics
Dewey Shurtleff

Section 15. Incidence of Cerebrovascular Accident by sex, age and level of characteristic at exam for 22 characteristics
Dewey Shurtleff

Section 16. Incidence of Brain Infarction by sex, age and level of characteristic at exam for 22 characteristics
Dewey Shurtleff

Section 17. Incidence of Intermittent Claudication by sex, age and level of characteristic at exam for 22 characteristics
Dewey Shurtleff

Section 18. Incidence of Congestive Heart Failure by sex, age and level of characteristic at exam for 22 characteristics
Dewey Shurtleff

Section 19. Incidence of Death by sex, age and level of characteristic at exam for 22 characteristics
Dewey Shurtleff

Section 20. Incidence of Death from Coronary Heart Disease by sex, age and level of characteristic at exam for 22 characteristics
Dewey Shurtleff

Section 21. Incidence of Death from Cardiovascular Disease by sex, age and level of characteristic at exam for 22 characteristics
Dewey Shurtleff

PREVIOUS SECTIONS

Section 22. Incidence of Death from Cause other than Cardiovascular Disease by sex, age and level of characteristic at exam for 22 characteristics
Dewey Shurtleff

Section 23. Serum cholesterol, systolic blood pressure and Framingham relative weight as discriminators of cardiovascular disease
Tavia Gordon and Joel I. Verter

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service National Institutes of Health