Relationship of Obesity and Disease in 73,532 Weight-Conscious Women

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When more food than is proper has been taken, it occasions disease. —Hippocrates

IT IS PARADOXICAL that the fat cell may have saved early man from extinction in his uncontrollable environment whereas the accumulation of fat cells in the obese person in our affluent society is possibly a liability. Apparently one of the fat cell's primary functions, to store energy, is no longer as essential for man's survival in our society. Thus the question is whether we should prevent the accumulation of these cells in our body.

Presently, there is a controversy as to whether obesity is deterimental to health *(1–4)*. Unsupported statements in the literature, such as "Only extreme degrees of obesity carry health hazards" *(1)*, tend to cloud the issue.

Our purpose was to determine whether obesity was associated with an increased risk of certain disease conditions in a population of 73,532 obesity-prone women living in the United States and Canada. We believed that the results of studying this large population of women would bring home to the general public the facts about pathophysiology associated with obesity. If obesity was a risk factor in certain diseases, we believed a study of this size might establish the obesity problem on a firm foundation—in the same way that the cigarette-lung cancer effort in preventive medicine was established by the large American Cancer Society studies. Only after the association between smoking and lung cancer had been demonstrated by the American Cancer Society studies in a large human population were meaningful programs to prevent lung cancer initiated.

The Epidemiologic Approach

Obesity may be considered a dynamic process of accumulating and "filling" fat cells. The extra tissue is carried by the musculoskeletal system, resulting in an additional tax on essential organs such as the heart, liver, and kidneys. This process of "supporting and carting" of weight for many years apparently takes its toll on the vascular system *(4)*. To determine whether fat taxes other body systems, a large cohort study was desirable. This would offer the opportunity to evaluate the natural history and consequences of obesity over a long period.

The search for etiological factors in a cohort study requires extraordinary planning, long-term commitments, a well-controlled experimental study, the cooperation of participants, and patience. Since it is difficult to meet all of these requirements simultaneously, epidemiologic studies usually resort to "the next best thing." In other words, fortuitious groupings of people are sought out and studied, such as AT&T employees or Metropolitan Life Insurance policyholders *(6)*. Usually the group is subdivided, and the presence and the absence of disease in the subgroups determined. Results of such studies are subject, however, to the criticism that observed differences between subgroups may be attributable to some extraneous factor, rather than to the one under study. When randomization

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techniques are not employed, the study groups may not be representative of the population to which inferences are made. Biases may be present that prevent reliable results. For example, if there were a positive correlation between the obesity level and hypertension, a legitimate criticism might be that *(a)* the larger circumference of the arms of very obese subjects affects the indirect measurement of their blood pressure by artificially raising it; *(b)* very obese women, usually being hypochondriacs, claim to have all kinds of diseases; or *(c)* women who are studied are "uptight" about weight control and do not represent the obese U.S. female population.

The epidemiologist is constantly aware of such criticisms, but he has some scientific "remedies." One method to evaluate whether a cross-sectional study contains biases is to determine the specificity of certain relationships. For example, if very obese women are said to be more hypochondriac than women of ideal weight, then we would expect that very obese women would have a higher prevalence of all the diseases studied than women of a desirable weight.

Even though the number of women in the current study is large, the results apply only to the specific group studied and must not be considered representative of all women in the United States.

Study Population

The subjects of this study were all TOPS members. TOPS (Take Off Pounds Sensibly) is an organization that had been started in 1948 in Milwaukee, Wis., under the leadership of Esther Manz. In 1969, its membership totaled more than 250,000 people in North America and foreign countries. The median duration of membership is 2.5 years. TOPS has no commercial ties and operates under a five-point philosophy for obtaining weight goals set by each member's physician. These points are: *(a)* medical orientation, *(b)* competition, *(c)* recognition, *(d)* group therapy, and *(e)* obesity research. The research reported here is only a part of the TOPS obesity research program *(7,8)* all of which is supported by contributions of members.

In 1969, almost 125,000 questionnaires were sent to TOPS chapter leaders in the United States and Canada, and by the end of the year more than 83,000 had been returned by TOPS members in sealed envelopes. Each woman who participated in this investigation volunteered her time and effort to complete a comprehensive questionnaire about herself and her close relatives. All of the women were weight conscious. They recognized that information about themselves would contribute to a better understanding of the problem common to all TOPS members. These characteristics promoted an esprit de corp that was reflected in the thoroughness of the women's answers on the structured questionnaire and in their monetary contributions to support the program.

Description of Sample

Those women who did not record their current height and weight on the questionnaire (usually because they did not return part 2) were excluded from the data file. The reporting of weight is believed to be accurate because one function of the TOPS organization is to keep each member aware of her weight from week to week. At each weekly meeting the member is weighed, and her weight is recorded by the leader. The woman is taught to be objective about her weight.

Males and nonwhites were excluded from the main data file because of the small number in these groups. The resultant size of the sample of TOPS members in this data file was 73,532. Missing information on certain questions (such as parity) prevents inclusion of all subjects in each analysis.

Table 1 gives the average weights for the TOPS population and the estimated weights for the U.S. female population by age and height. The U.S. population figures are from the Health Examination Survey, in which 6,672 persons were examined. Overall, this table shows that the TOPS sample studied was heavier than the U.S. population.

The ratio of weight to height is used to measure the degree of obesity. This ratio had the lowest correlation with height and the highest correlation with weight. These correlations are in agreement with those in another study of women by Florey *(12)*. The scale for

Tabe 1. Average weight of 73,532 TOPS members and of U.S. population 1960–62, by height and age group

Height and population	Age group (years)					
	15–24[1]	25–34	35–44	45–54	55–64	65–74
59 inches:						
TOPS	144	143	147	144	144	139
U.S.	121	118	138	135	141	143
60 inches:						
TOPS	150	154	158	156	156	152
U.S.	122	124	138	137	148	142
61 inches:						
TOPS	151	155	160	159	159	157
U.S.	124	127	137	150	147	146
62 inches:						
TOPS	158	161	165	165	163	160
U.S.	128	133	143	143	159	154
63 inches:						
TOPS	162	167	169	168	166	165
U.S.	126	135	146	146	160	145
64 inches:						
TOPS	165	170	173	172	172	169
U.S.	126	140	147	155	156	158
65 inches:						
TOPS	172	174	177	176	175	168
U.S.	135	142	140	156	161	145
66 inches:						
TOPS	174	177	182	180	178	176
U.S.	142	139	148	157	145	154
67 inches:						
TOPS	182	183	187	186	185	184
U.S.	140	154	154	171	172	219
68 inches:						
TOPS	187	190	191	193	189	181
U.S.	131	150	160	169	158	200

[1] Range for U.S. population was 18–24 years.

NOTE: Source of U.S. population data was National Center for Health Statistics: Weight by height and age of adults—United States, 1960–1962. PHS Publication No. 1000. Vital and Health Statistics, Series 11, No. 14. U.S. Government Printing Office, Washington, D.C., May 1966.

Table 2. Descriptive statistics for TOPS women at five obesity levels

Factor	Level 1	Level 2	Level 3	Level 4	Level 5
Obesity index[1]					
Minimum value	1.10	2.22	2.45	2.70	3.07
Maximum value	2.21	2.44	2.69	3.06	7.60
Ever smoked—total respondents[2]	11,860	12,266	11,883	11,554	11,594
Yes respondents	5,130	5,111	4,943	4,737	5,198
Percentage ever smoked	43.2	41.7	41.6	41.0	44.8
Age—total respondents[2]	13,998	14,805	14,480	14,277	14,613
Mean years	38.4	40.0	40.5	40.7	39.8
Standard deviation	12.5	12.7	12.5	12.1	11.3
Height—total respondents[2]	14,284	15,077	14,738	14,567	14,866
Mean inches	63.7	64.1	64.3	64.4	64.6
Standard deviation	2.5	2.4	2.5	2.5	2.6
Weight—total respondents[2]	14,284	15,077	14,738	14,567	14,866
Mean pounds	132.1	149.7	165.2	184.7	227.9
Standard deviation	9.3	7.3	7.9	9.9	29.0
Percentage above desirable weight[3]	10.1	24.8	37.8	53.9	85.3

[1] Weight divided by height.
[2] Totals differ because not all women answered all questions.
[3] Based on mean height and weight; desirable weight based on Metropolitan Life Insurance standard.

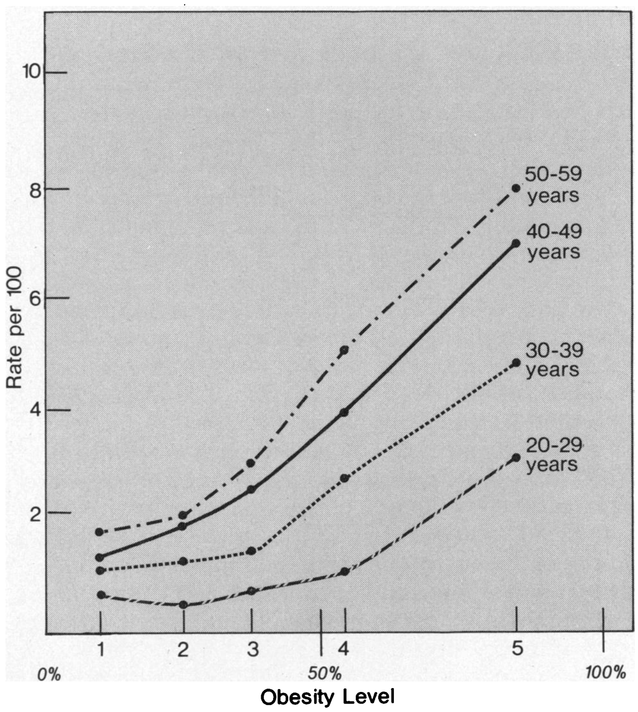
this ratio is divided into five intervals (table 2). The resulting five-point scale was constructed to include 20 percent of the population at each obesity level. The errors inherent in using a simple formula to determine the degree of obesity increase the unexplained variability between subjects because other anthropometric measurements are not considered. This increased variability tends to obscure the association of a given factor with the degree of obesity, an association which might be apparent with a more refined index; that is, associations that are present may be missed.

In all the subsequent analyses in this paper, pregnant women have been excluded because their recorded "present weight" might not provide an accurate basis for estimation of their nonpregnant weight. Also, with the exception of figure 1, diabetic women have been excluded from all subsequent analyses.

Design of Questionnaire

An extensive 16-page questionnaire was developed to examine all aspects of the life of each participant. It was divided into two major parts. Part 1 was filled out at the local chapter meeting of TOPS under the supervision of the leader, who was given step by step instructions. This part contained *(a)* a hand tracing of the member, *(b)* menstrual and pregnancy history (miscarriages, length of gestations), *(c)* medical history (diabetes, other diseases, allergies, surgical operations), *(d)* eating habits and food preferences, *(e)* smoking habits, *(f)* weight-control regimens, *(g)* medical history of close relatives, and *(h)* physician's name and address. Part 2 was completed at home and returned in a sealed envelope at the following chapter meeting. This part contained *(a)* socioeconomic factors for member and spouse (age, country of origin, family income, occupation, education), *(b)* current body measurements (such as height, weight, dress size, glove size, hat size, waist, and hips), *(c)* previous weight of member (maximum and minimum by previous decades of life, excluding pregnancy), *(d)* current information on close relatives (height, weight, age, state of health, or cause of death), *(e)* birth weights and body lengths for all natural born children, and *(f)* physical activities of the member.

Figure 1. Obesity and age-specific occurrence rates for women with a history of adult onset of diabetes



NOTE: Obesity level is expressed on a scale of percentage above ideal weight.

A two-page questionnaire was also used to obtain clinical information from the subject's physician. The physicians of a random sample of the women who had signed physician releases for their health data were mailed this specially designed medical history questionnaire. The form contained the following information on each woman: *(a)* clinical laboratory test results (such as urinalysis, blood chemistries, thyroid uptake), *(b)* treatment of obesity (diet, medication), *(c)* psychological evaluation (stability, personal relationships, cooperation), *(d)* disorders for which the patient had been treated (cardiac, thyroid, gallbladder), and *(e)* information on diabetes (initial and present treatment and age and weight at diagnosis).

The data from our study were evaluated both for reproducibility and validity. The results agreed with those reported for a study by Mark *(9)* in which a mailed questionnaire was used. Recent studies of underreporting and overreporting of chronic conditions in an interview setting suggest that these two sources of error could offset each other for diabetes, heart conditions, and gallbladder disease. A relatively high index of overreporting was found for hypertension, and the women had a greater tendency to overreport than underreport their conditions *(10)*.

A new computer system named SCALPEL was instituted to allow easy dissection of the data by frequency distributions, means, standard deviations, and cross tabulations *(11)*.

Results

Our study was focused on the association between obesity and 18 different disease conditions. The women in the study reported on these conditions in response to the question, Has a doctor ever said you had *(name of disease)*? A *Yes* answer indicated that to the best of the woman's knowledge she had a history of the disease in question. The questionnaire also elicited information concerning the date when the condition was first noted by her physician, the duration of the disease, and whether treatment was prescribed. Studies are presently underway analyzing this additional information about each disease condition.

In this cross-sectional study the statistic used to reflect the disease rate is referred to as the occurrence rate; it is calculated as follows:

$$\frac{N_D}{N_T} \times 100 = \text{rate per 100 subjects with the disease condition}$$

$$\text{where } N_D = \text{number of subjects reporting a history of the disease}$$

$$\text{and } N_T = \text{total number of subjects at risk.}$$

This rate reflects a lifetime rate for the age-specific groups studied. For example, a rate of 10 per 100 for high blood pressure for the age group between 30 and 49 years indicates that 10 women in 100 in this age group had a history of high blood pressure (whether or not they had the condition when they answered the questionnaire).

We would expect higher rates for the older age groups because the rate reflects lifetime experience. To simplify the comparison for the 18 disease conditions studied, only age-specific rates for the women between 30 and 49 years are given.

Table 3. Percentages of TOPS women 30–49 years with selected disease conditions, by obesity level

Disease condition[1]	Level 1		Level 2		Level 3		Level 4		Level 5		Crude relative risk[4]	P value (chi square)[5]
	Total women[2]	Percent Yes[3]	Total women[2]	Percent Yes[3]	Total women[2]	Percent Yes[3]	Total women[2]	Percent Yes[3]	Total women[2]	Percent Yes[3]		
Diabetes	7,320	1.3	7,792	1.6	7,657	2.0	7,796	3.4	8,544	5.8	4.54	...$P<.001$
High blood pressure	6,973	15.1	7,358	20.3	7,200	26.6	7,220	33.3	7,644	50.1	3.32	
Gallbladder disease	6,938	8.9	7,342	12.1	7,190	14.6	7,194	17.7	7,603	24.3	2.73	
Gout	6,951	.9	7,342	1.3	7,208	1.2	7,215	1.8	7,615	2.3	2.56	
Hypothyroidism	6,886	18.1	7,272	19.5	7,121	24.3	7,144	24.8	7,527	29.4	1.62	
Heart disease	6,958	3.0	7,322	3.3	7,203	3.7	7,206	4.1	7,610	4.7	1.57	
Arthritis	6,947	13.3	7,344	15.3	7,178	16.3	7,201	17.6	7,618	20.6	1.55	
Other thyroid	6,867	2.6	7,250	3.0	7,087	2.7	7,091	3.4	7,479	3.8	1.46	
Jaundice	6,954	5.2	7,349	5.9	7,201	6.0	7,202	6.3	7,607	7.0	1.35	
Stroke	6,958	.3	7,348	.2	7,213	.3	7,223	.3	7,622	.5	1.67	...NS
Hyperthyroidism	6,863	2.4	7,222	3.0	7,069	2.7	7,074	2.7	7,423	3.1	1.29	
Epilepsy	6,955	.4	7,350	.5	7,202	.5	7,219	.5	7,619	.5	1.25	
Bleeding problems	6,944	6.6	7,308	6.3	7,186	6.1	7,195	6.1	7,597	7.5	1.14	
Kidney disease	6,910	11.8	7,312	11.8	7,170	12.2	7,171	12.6	7,582	13.3	1.13	
Peptic ulcer	6,956	5.9	7,355	6.4	7,200	6.8	7,217	6.8	7,611	6.3	1.07	
Lung disease	6,934	6.8	7,316	7.1	7,185	6.4	7,180	6.7	7,583	7.3	1.07	
Goiter	6,971	4.3	7,352	5.0	7,219	4.5	7,223	4.1	7,624	4.3	1.00	
Anemia	6,944	26.5	7,326	25.8	7,188	25.4	7,176	23.0	7,603	22.2	.84	

[1] Women with diabetes are included only in the first category. Pregnant women are excluded from all categories.
[2] "Total women" means total women in the specified age group at specified obesity level. Totals differ because not all women answered all questions.
[3] Percentage who replied Yes on questionnaire to query as to whether they had experienced particular disease condition.
[4] Found by dividing the percentage of Yes answers of women at obesity level 5 by the percentage of Yes answers by women at obesity level 1.
[5] $P < .001$ required for statistical significance. NS—not statistically significant ($P < .001$.)

Table 3 gives these age-obesity-specific rates for each disease condition. Using the chi-square test and at least a $P<$ .001 level to indicate statistical significance, we found 10 disease conditions to be significantly correlated with the degree of obesity. For one of these, anemia, there was a negative trend; that is the rates were lower in the severely obese.

Relative risk. It is unfortunate that we did not have a "clean" control group for comparative purposes. A control group of women who had been of ideal weight throughout their lives would have afforded direct comparisons between obese women and women of ideal weight. Since such comparisons were not possible, women who at the time of this study were close to their ideal weight were used as controls (weight level 1) for the calculation of obesity-related risks (table 3).

To summarize the relationship between obesity and the age-specific rates, crude relative risks were calculated for each disease condition. In calculating these risks, the women who were closest to their undesirable weights were used as the base:

$$\frac{R_V}{R_C} = \text{crude relative risk}$$

R_V = number with disease at obesity level 5 divided by the total number of subjects at obesity level 5 who were at risk.

R_C = number with disease at obesity level 1 divided by the total number of subjects at obesity level 1 who were at risk.

This ratio may be used to reflect the risk of having a history of the disease for the group with the highest weight as compared with the risk for the group with lowest weight. The fact that the ratio in the denominator is from the lowest weight group and that some of these women possibly may have been heavier sometime earlier in their lives may have elevated the percentage with disease. If this is the case, the risks presented in table 3 give a conservative estimate of the risks related to obesity.

Diabetes mellitus. The association between obesity and diabetes mellitus is well known *(3,13,14)*. However, the mechanism for their coexistence is not clearly understood; the role that genetic determinants play in this relationship is also unclear. It is generally acknowledged that the trait for diabetes mellitus is inherited as a simple Mendelian recessive with incomplete penetrance. Homozygosity for the trait is estimated to

Table 4. Percentages of TOPS women 20–49 years with selected disease conditions, by age group and obesity level

Disease condition and age group	Level 1		Level 2		Level 3		Level 4		Level 5	
	Total women	Percent Yes	Total women	Percent Yes	Total women	Percent Yes	Total women	Percent Yes	Total women	Percent Yes
Diabetes:										
20–29	2,997	0.7	2,675	0.5	2,443	0.8	2,267	1.1	2,453	3.1
30–39	4,113	1.2	4,074	1.3	3,961	1.5	4,006	2.8	4,440	4.8
40–49	3,207	1.4	3,718	1.9	3,696	2.6	3,790	4.0	4,104	7.0
50–59	2,034	1.8	2,435	2.1	2,482	3.1	2,472	5.1	2,190	8.1
High blood pressure:										
20–29	2,895	13.8	2,569	17.6	2,366	22.8	2,180	30.7	2,300	46.3
30–39	3,940	13.6	3,868	18.5	3,774	25.1	3,761	30.3	4,034	47.1
40–49	3,033	16.9	3,490	22.2	3,426	28.3	3,459	36.6	3,610	53.3
50–59	1,875	27.4	2,222	34.0	2,266	41.1	2,155	50.0	1,792	63.6
Gallbladder disease:										
20–29	2,897	4.3	2,574	6.3	2,366	7.5	2,176	8.0	2,308	11.1
30–39	932	7.2	3,874	10.0	3,782	13.1	3,751	15.8	2,028	21.8
40–49	3,006	11.1	3,468	14.4	3,408	16.4	3,443	19.7	3,575	27.0
50–59	1,854	14.7	2,189	18.7	2,227	20.1	2,116	25.8	1,763	30.5
Heart disease:										
20–29	2,902	3.1	2,573	2.3	2,368	2.3	2,184	2.2	2,305	2.5
30–39	3,937	2.8	3,859	2.8	3,785	3.2	3,744	3.7	4,037	3.6
40–49	3,021	3.3	3,463	3.9	3,418	4.3	3,462	4.5	3,573	6.0
50–59	1,844	7.0	2,194	6.8	2,218	7.8	2,125	10.4	1,749	10.1
Anemia:										
20–29	2,892	24.5	2,570	21.8	2,363	19.6	2,174	18.0	2,302	16.6
30–39	3,928	25.7	3,863	26.3	3,766	24.9	3,730	23.4	4,021	22.1
40–49	3,016	25.6	3,463	25.3	3,422	25.9	3,446	22.6	3,582	22.3
50–59	1,860	23.0	2,194	21.4	2,225	21.2	2,127	20.5	1,755	18.1
Jaundice:										
20–29	2,907	2.9	2,579	3.6	2,367	4.5	2,183	3.6	2,305	3.8
30–39	3,937	4.5	3,881	5.3	3,783	5.2	3,749	6.0	4,035	6.3
40–49	3,017	6.1	3,468	6.6	3,418	6.8	3,453	6.6	3,572	7.8
50–59	1,849	6.3	2,178	6.5	2,217	9.1	2,123	8.5	1,750	9.2

NOTE: "Total women" means total women in the specified age group at the specified obesity level. "Percent Yes" is the percentage who replied Yes on the questionnaire to query as to whether they had experienced the particular disease.

be present in about 5 percent of the U.S. population. Obesity is believed to increase the risk of diabetes for those with predisposition (or inherited trait) for the disease *(15)*.

Parts of table 4 and figure 1 give the age-specific and obesity-specific rates for women with a history of adult onset of diabetes. Figure 1 indicates that the rate of diabetes in the study population increased with age and the obesity level. The rates for the 50-year-old woman are somewhat biased because mortality is higher among very obese diabetics than nondiabetic women, and thus fewer survive to be included in the oldest age group *(16)*.

Since diabetes is known to be associated with other disease conditions *(17)*, such as cardiovascular disease, women with diabetes have been excluded from our detailed analysis of the association between obesity and the other diseases studied.

Hypertension. A review by Chiang and associates *(2)* of 39 different studies concerned with the relationship between hypertension and obesity clearly indicates the existence of such an association; a more dramatic relationship between the two was observed among women than among men. The risk of hypertension (systolic, diastolic, or both) among obese women was six times higher than among underweight women, whereas in men the risk of hypertension was about four times higher in the obese *(18)*.

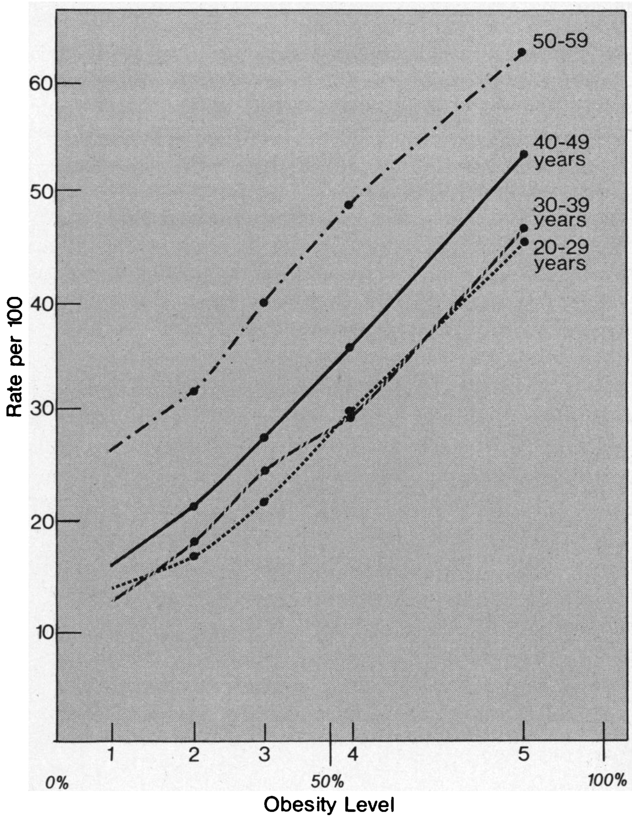
In studies relating obesity with hypertension, the question of bias in the indirect measurement of blood pressure in obese persons with large arm circumferences has been raised. In a review of seven studies concerned with this problem, Chiang and associates *(2)* conclude that "Recent studies on the effect of arm circumference on pressure readings appear to have shown that the discrepancy is minor in the majority of cases, and the difference between direct intraarterial and indirect cuff readings varies in either direction in obese as well as nonobese subjects."

The criteria for diagnosing hypertension are not uniform. Physicians differ widely both in their definition of the condition and in their methods for evaluating it. In a survey of the magnitude of the TOPS study (in which thousands of physicians are involved), the lack of uniformity of diagnostic criteria would contribute to random variation and tend to obscure the relationships between hypertension and other factors. Therefore, if a relationship is found, then it would be safe to say that it truly exists. An important consequence of this question of error is that certain relationships will appear to be nonexistent, when in fact they do exist.

The data on hypertension for this study were obtained in response to the question, Has a doctor ever said you had high blood pressure? The results reported are in agreement with those for clinical studies in which indirect measurements were made of systolic and diastolic blood pressure *(2)*.

Parts of table 4 and figure 2 show age-specific rates for high blood pressure at each obesity level. As the obesity level increased, the percentage of women reporting a history of high blood pressure increased ($P <$ .001). As expected, the rates were higher for the older age groups.

Figure 2. Obesity and age-specific occurrence rates for women with a history of high blood pressure



NOTE: Obesity level is expressed on a scale of percentage above ideal weight.

It is noteworthy that the age-specific rates indicate that obesity is closely associated with hypertension even in the youngest age group. One interpretation of this association could be that obesity is a risk factor that increases the risk of high blood pressure in all age groups similarly.

Gallbladder disease. Ingelfinger *(19)* has estimated that 15 million Americans have gallstones. He further estimates that the medical costs for care of these patients amounts to half a billion dollars per year. Even though this disease is of major importance, there have been few population studies or surveys focused on identifying the etiological factors associated with it. Ingelfinger states: "Why indeed has the study of gallstones been lagging in general? In view of the prevalence of gallstones and the major disabilities they cause, there is not a satisfactory answer to this question. One can only conclude unhappily that gallstones have not been an *in* disease."

The literature contains a number of survey-type studies of gallbladder disease in American Indians *(20,21)*; however, the only definitive survey of the U.S. Caucasian population is the Framingham study *(22)*. In this study of 5,209 men and women, the incidence of gallbladder disease was found to be about twice as high in women as in men, and it increased with age in both sexes without any evidence of an excess in the forties.

Weight and the number of preganancies were each associated with gallbladder incidence. Also, the Framingham results showed that "dietary fat, protein, cholesterol intake, level of physical activity, age at menopause, marital status and precinct of residence were not related to gallbladder disease" *(22)*.

Table 4 shows that the rate of women reporting gallbladder disease increases with age. Also, there is a significant association *($P<.001$)* between the percentage with a history of this disease and the women's obesity level. An in-depth analysis of these data suggest that both age and obesity have independent roles in their association with gallbladder disease. Also, it appears that these roles are additive; that is, older obese women have a higher incidence than younger obese women. In addition, it is estimated that obesity was six times more important than age in explaining gallbladder incidence rates *(23)*.

In the Framingham study *(22)*, 12.3 percent of the women 20 percent above the median weight who were over 30 years of age had a history of gallbladder disease at the beginning of the study. In our study, 16.5 percent of the women 20 percent above their ideal weight and more than 30 years of age reported that they had gallbladder disease. The probable reason for a higher rate in our study is that the obese women in TOPS were considerably heavier than those in the Framingham study. Also, the criteria for obesity were not the same in the two studies.

Anemia. To our knowledge no epidemiologic studies have focused on the relationship between obesity and anemia. Almost a quarter of the TOPS population reported having a history of anemia (table 4). This disease condition was the only one studied which had an inverse relationship with the degree of obesity.

Heart disease. Gofman and Young found that when the diastolic pressure and the serum lipoprotein levels were held constant, "no residual independent contribution of overweight per se to the risk of coronary heart disease can be discerned" *(24)*.

In a review article, Epstein states that "obesity per se is a less potent risk factor than either serum cholesterol or blood pressure level so that control of obesity alone is not likely to make a major dent in the frequency of coronary disease" *(25)*. In a prospective study. Heyden and associates found that "excessive weight gain after age 20 seems to be of no major importance in the etiology of myocardial infarction" *(26)*.

The pituitary-ovary axis in premenopausal women offers a measure of protection from atherosclerotic heart disease. This could be one reason whey the rates for coronary disease reported here are low. Another reason could be that there is a selection process operating so that persons with heart disease die or do not join weight-reduction clubs. Nonetheless, we found a relationship between heart disease and obesity (table 4).

Jaundice. To our knowledge there have been no studies focusing on the relationship between jaundice and obesity. The results in table 3, however, indicate a statistically significant relationship between the two.

Hypothyroidism. The significant relationship that has been observed between obesity and hypothyroidism must be interpreted carefully. There is a tendency to attribute obesity to impaired thyroid function, a tendency resulting in incorrect diagnoses and inappropriate treatment with a thyroid hormone. It is generally recognized that only 1 or 2 percent of the population have hypothyroidism, and even those in whom the condition is relatively far advanced carry about 6.0 lbs. to 14.9 lbs. in excess weight *(27–29)*. Thus, the rates observed in this study probably reflect an artifact of medical practice. That this phenomenon exists in our obesity-conscious culture is not surprising. The patient is anxious to hear that her obesity is attributable to a disease condition because the patient is thus exonerated from blame for it. Also, the physician knows that he will achieve some measure of therapeutic effectiveness with a thyroid hormone.

Arthritis and gout. Weight reduction often reduces the symptoms in bone and joint diseases, especially if the bones and joints causing trouble are weight-bearing ones *(30)*. In this study both gout and arthritis were found to be related to obesity (table 3). The rates for arthritis were considerably higher than those for gout, as was expected.

Other diseases. Although lung disease has been thought to be associated with obesity *(15)*, such an association was not found in this study. The types of problems associated with the data in our study tend to obscure existent relationships. Thus, the results presented here probably give a conservative estimate of the conditions that are related to obesity.

Discussion

There are difficulties in this kind of study in establishing whether a person has had specific disease conditions, especially when a disease process has been mild. For example, in reporting a history of an illness, the TOPS member was reporting what she believed she was told by her physician. Physicians, in turn, frequently disagree as to where normality leaves off and abnormality starts. Thus, while one physician may demand significantly abnormal clinical and laboratory results before making a diagnosis, another may make a diagnosis on the basis of minor symptomatic changes or minor changes in laboratory results.

Thus, the strength of an epidemiologic study such as this lies not so much in the absolute rate of disease in the study population as in the result of comparing the frequency of the disease in persons at different obesity levels.

If we assume that the risks reflect the strength of the relationship between obesity and each reported disease, it is useful to order the satistically significant disease conditions (table 3). These results suggest that severe obesity in women between 30 and 49 years of age increases the risk of diabetes 4.5 times, high blood pressure 3.3 times, gallbladder disease 2.7 times and gout 2.56 times. Although these relationships were found to exist, obesity is not implied to be the cause of these conditions.

Conclusion

This study, in which more than 73,000 highly motivated women "laid bare" their personal lifestyles and health histories, offered a unique opportunity to study obesity. The general agreement of the results with those of other studies indicates to a certain extent the validity of the current data.

Although epidemiologic studies such as this one are not designed to uncover the metabolic mechanisms explaining the coexistence of disease and obesity, they can serve three distinct purposes:

1. They can uncover the factors associated with obesity.
2. They can trigger clinical investigations of new and provocative hypotheses about obestiy.
3. They can alert the medical profession to their results so that preventive programs can be planned.

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SYNOPSIS

RIMM, ALFRED A. (Medical College of Wisconsin), WERNER, LINDA H., VAN YSERLOO, BARBARA, and BERNSTEIN, RONALD A. ***Relationship of obesity and disease in 73,532 overweight women, Public Health Reports, Vol. 90, January-February 1975, pp. 44–51.***

The relationship between obesity and 18 different disease conditions was examined in a cross-sectional study of 73,000 weight-conscious women (TOPS Club members). The women reported an average of 1.6 disease conditions each (based on their responses on a questionnaire).

Age-specific rates of occurrence for the age group 30—49 years were calculated for each disease condition. The conditions that were found to be significantly ($P<.001$) correlated with obesity were diabetes, high blood pressure, gallbladder disease, gout, thyroid disease, heart disease, arthritis, and jaundice. When the crude relative risks of obesity for each disease condition were calculated, diabetes was found to be the highest (4.5), high blood pressure was second (3.3), and gallbladder disease was third (2.7).