

ASSOCIATION OF THE CHRONIC DISEASES IN THE SAME PERSON AND THEIR ASSOCIATION WITH OVERWEIGHT

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THE problem of chronic disease has become one of the major concerns of public health. Conditions classed as "chronic" lead to a great deal of incapacity during middle age, the most productive years of life. A study of morbidity conducted in the Eastern Health District of Baltimore has revealed that only 14 per cent of the total population was affected by chronic disease. However, one-third of all of the medical calls rendered to the population annually and about one-fourth of the hospital admissions were because of chronic illness. These facts serve to emphasize the gravity of the problem of chronic disease.

A study of the association of the chronic diseases in the same person and their association with overweight in a sample population is of more than academic interest. Data from the morbidity survey made in the Eastern Health District of Baltimore are used for this study and are presented in this report.

DATA AND METHOD OF STUDY

The data presented in this analysis include persons with one or more major chronic conditions reported to be present in a sample of families living in the Eastern Health District of Baltimore during the period June, 1938 to May, 1943. Briefly, the method of study was as follows: Families living in thirty-four city blocks were visited at monthly intervals to obtain a record of illness among their members. In seventeen of the thirty-four city blocks the families were visited over a period of five years; in the other seventeen visiting was continued for only three years in families where no persons with chronic disease were reported during that period.

The instructions for the use of the family visitors contained

¹ From the Milbank Memorial Fund.

a list of the more common chronic diseases about which special inquiry was to be made. This special information included date of onset of the first symptoms of the disease, their nature, the date first diagnosed, and whether the diagnosis was made by a private physician, at a clinic, or at a hospital. Illnesses that were reported as chronic were asked about on each subsequent visit to the family. Inquiry was made concerning the amount of discomfort and disability suffered from the condition since the last visit and the amount of medical care received for it.

The causes of chronic illness as reported by the family informants were submitted to the attending physicians for confirmation or correction. The cases which had clinic attendance and those which had hospital admissions were also checked against the records of the clinic or hospital where the service was given. The only exception to this procedure was for cases hospitalized outside the City of Baltimore.

The data include "major" chronic conditions reported for persons in families observed two months or longer. Hence the shortest possible period of observation was two months and the longest was from three to five years.

The method of statistical analysis of chronic illness in a longitudinal study such as that in the Eastern Health District of Baltimore has been described fully in a previous paper (1). It has been pointed out also that persons with specific chronic conditions, when observed over a period of time, have the risk of developing other chronic conditions which may or may not be related one to the other (2).

The population considered here is composed of all persons 20 years of age and older and is expressed in person-years of observation. These numbered 17,913. Cases of chronic illness were counted in each year in which they were present. Rates based on cases counted in this manner and on person-years of observation represent an annual prevalence.

ASSOCIATION OF CHRONIC CONDITIONS

The classification "major" chronic disease includes heart

disease, hypertensive vascular disease, arthritis, tuberculosis, diabetes, chronic nephritis, rheumatic fever, varicose veins, chronic gall-bladder disease, syphilis, malignant neoplasm, peptic ulcer, toxic goiter, epilepsy, mental deficiency, psychoses and psychoneuroses, and other important but relatively rare conditions.

When these conditions are arrayed according to the level of their prevalence in the population aged 20 and over, arthritis, heart disease, and diseases of the vascular system are the most important causes of chronic illness. Next in order are the psychoneuroses and nervousness, varicose veins, gall-bladder disease, and diabetes (2). Other conditions were present in the population much less frequently and will not be considered in this analysis.

Table 1 shows the observed and expected number of persons 20 years of age and older with both heart disease and gall-bladder disease and those with both heart disease and diabetes. The expected numbers with both conditions, as shown in Table 1, result from the cross-products of the prevalence rates for each condition. For example, there were 159 cases of gall-bladder disease and 686 cases of heart disease among the 17,913 person-years of observation. The resulting rates were .0089 and .0383, respectively. The cross-product of these rates, .0003, is the rate at which both types of chronic disease would be expected to be present in the same person if

Table 1. Observed and expected number of persons with multiple chronic conditions.

CLASSIFICATION WITH RESPECT TO CHRONIC CONDITION	OBSERVED NUMBER	EXPECTED NUMBER	CHI-SQUARE	P
Both Heart Disease and Gall-Bladder Disease	11	5.37	6.18	<.02
Heart Disease Only	675	680.69		
Gall-Bladder Disease Only	148	154.05		
Neither Heart Disease nor Gall-Bladder Disease	17,079	17,072.88		
Both Heart Disease and Diabetes	11	5.37	6.22	<.02
Heart Disease Only	675	680.69		
Diabetes Only	144	150.47		
Neither Heart Disease nor Diabetes	17,083	17,076.46		

CLASSIFICATION WITH RESPECT TO CHRONIC CONDITION	OBSERVED NUMBER	EXPECTED NUMBER	CHI-SQUARE	P
Both Heart Disease and Arthritis	42	32.24	3.22	> .05
Heart Disease Only	644	653.82		
Arthritis Only	793	802.50		
Neither Heart Disease nor Arthritis	16,434	16,424.43		
Both Heart Disease and Varicose Veins	10	8.96	0.12	> .70
Heart Disease Only	676	677.11		
Varicose Veins Only	209	209.58		
Neither Heart Disease nor Varicose Veins	17,018	17,017.35		

Table 2. Observed and expected number of persons with multiple chronic conditions.

such conditions occurred at random in the population. Application of this rate to the 17,913 person-years gives the expected number of 5.37 persons. The observed number was 11.

The chi-square test was then applied to test the hypothesis that the difference between the observed and expected frequencies may be due to chance variation.

Both gall-bladder disease and diabetes showed a statistically significant association with heart disease. The association of diabetes and heart disease is not surprising since heart disease in many instances may represent an advanced degree of vascular degeneration. According to Dolger, premature vascular degeneration is an integral part of the clinical syndrome of diabetes mellitus (3). The reason for the significant association of heart disease with gall-bladder disease seems obscure but will be discussed further in another part of this paper.

Table 2 shows the observed and expected number of persons with both heart disease and arthritis and those with both heart disease and varicose veins. In the experience of this study, neither arthritis nor varicose veins was found to be associated significantly with heart disease.

Table 3 shows the observed and expected number of persons with both hypertensive vascular disease and gall-bladder disease and those with both hypertensive vascular disease and arthritis. In both instances, that of gall-bladder disease and of arthritis, there was a statistically significant association with hypertensive vascular disease. The association of these chronic

CLASSIFICATION WITH RESPECT TO CHRONIC CONDITION	OBSERVED NUMBER	EXPECTED NUMBER	CHI-SQUARE	P
Both Hypertensive Vascular Disease and Gall-Bladder Disease	8	3.58	5.65	<.02
Hypertensive Vascular Disease Only	411	415.58		
Gall-Bladder Disease Only	151	155.84		
Neither Hypertensive Vascular Disease nor Gall-Bladder Disease	17,343	17,337.99		
Both Hypertensive Vascular Disease and Arthritis	29	19.70	4.71	<.04
Hypertensive Vascular Disease Only	390	399.46		
Arthritis Only	806	815.04		
Neither Hypertensive Vascular Disease nor Arthritis	16,688	16,678.79		

Table 3. Observed and expected number of persons with multiple chronic conditions.

conditions in the same person may be due to the fact that all have been found in many instances to be associated with overweight. Vilter and Thompson have said: "Obesity . . . places an excessive load upon the cardiovascular system and, through this strain, may accentuate hypertension and accelerate the appearance of arteriosclerosis. Excessive weight which must be borne by the large joints of the body accelerates the appearance of hypertrophic arthritis and adds to the suffering of the patient who has rheumatoid arthritis. It also . . . exerts a positive influence upon the occurrence of cholelithiasis and cholecystitis. . . ." (4).

Table 4 shows the degree of association of arthritis and gall-bladder disease and of arthritis with varicose veins. The

Table 4. Observed and expected number of persons with multiple chronic conditions.

CLASSIFICATION WITH RESPECT TO CHRONIC CONDITION	OBSERVED NUMBER	EXPECTED NUMBER	CHI-SQUARE	P
Both Arthritis and Gall-Bladder Disease	12	7.17	3.47	.07-.06
Arthritis Only	823	827.58		
Gall-Bladder Disease Only	147	152.26		
Neither Arthritis nor Gall-Bladder Disease	16,931	16,925.99		
Both Arthritis and Varicose Veins	6	10.75	2.26	.15-.14
Arthritis Only	829	823.99		
Varicose Veins Only	213	207.79		
Neither Arthritis nor Varicose Veins	16,865	16,870.46		

CLASSIFICATION WITH RESPECT TO CHRONIC CONDITION	OBSERVED NUMBER	EXPECTED NUMBER	CHI-SQUARE	P
Both Arthritis and Diabetes	8	7.16	.12	> .70
Arthritis Only	827	827.58		
Diabetes Only	147	148.68		
Neither Arthritis nor Diabetes	16,931	16,929.58		
Both Arthritis and Psychoneurosis	12	12.54	.02	> .80
Arthritis Only	823	822.21		
Psychoneurosis Only	269	268.69		
Neither Arthritis nor Psychoneurosis	16,809	16,809.56		

Table 5. Observed and expected number of persons with multiple chronic conditions.

chi-square value, 3.47, for arthritis and gall-bladder disease indicates a probability slightly above the 5 per cent level used as a limit for significance. Arthritis and varicose veins show no significant association.

There is no evidence of a significant association of arthritis and diabetes in the same person. The same was true of the presence of arthritis and psychoneurosis in the same person. In each instance the expected numbers were fairly similar to the observed numbers. These data are shown in Table 5.

Table 6 shows the observed and expected number of persons with psychoneurosis and gall-bladder disease. There the chi-square value, 5.87, indicates a statistically significant association of the two conditions in the same person. The expected number of such instances was approximately 2 and the observed number was 5. The probabilities of such an occurrence being due to normal variation was less than 2 in 100.

It is apparent from the data that certain chronic conditions occur with greater frequency in the same person than would

Table 6. Observed and expected number of persons with multiple chronic conditions.

CLASSIFICATION WITH RESPECT TO CHRONIC CONDITION	OBSERVED NUMBER	EXPECTED NUMBER	CHI-SQUARE	P
Both Psychoneurosis and Gall-Bladder Disease	5	1.79	5.87	< .02
Psychoneurosis Only	276	279.44		
Gall-Bladder Disease Only	154	157.63		
Neither Psychoneurosis nor Gall-Bladder Disease	17,478	17,474.13		

be expected if such conditions were distributed at random in the population. Those where the association of the two in the same person was found to be statistically significant are as follows: heart disease and gall-bladder disease, heart disease and diabetes, hypertensive vascular disease and gall-bladder disease, hypertensive vascular disease and arthritis, and psychoneurosis and gall-bladder disease. Those where there was no statistically significant association in the occurrence of both in the same person are as follows: heart disease and arthritis, heart disease and varicose veins, arthritis and gall-bladder disease, arthritis and varicose veins, arthritis and diabetes, and arthritis and psychoneurosis (5).

ASSOCIATION OF CHRONIC CONDITIONS AND OVERWEIGHT

At the present time much attention is being drawn to the problem of obesity in the population and its effect upon morbidity and mortality rates. According to Chapman, "Study after study has shown that the mortality rates among obese people are higher than among people of normal weight" (6, 7, 8). It is of definite interest, therefore, to learn what chronic conditions are significantly associated with overweight.

At the end of the third year of the morbidity study in the Eastern Health District of Baltimore, records of height and weight were obtained for the population under observation at that time. Persons who did not know their height or weight were asked to make a special effort to ascertain these facts and report them at the next visit of the investigator. Such records were obtained for 72 per cent of the males and 73 per cent of the females aged 20 and over. Table 7 shows the variation in the proportion at specific ages who reported height and weight. Males varied from 62 per cent at age 65 and over to 82 per cent at ages 25-34. Females varied from 65 per cent at ages 65 and over to 78 per cent at ages 35-44.

Records of height and weight obtained in the manner described are admittedly relatively crude. There was no effort to get height without shoes or weight without clothing. How-

AGE GROUP	MALE		FEMALE	
	Number of Persons Observed May and June, 1941	Per Cent with Height and Weight Record	Number of Persons Observed May and June, 1941	Per Cent with Height and Weight Record
20-24	205	73.2	239	66.9
25-34	394	82.0	418	76.3
35-44	358	69.0	371	78.2
45-54	332	69.6	316	76.3
55-64	173	70.5	196	66.3
65+	131	61.8	167	65.3

Table 7. Proportion of the population at specific ages for whom a record of height and weight was obtained.

ever, all records were obtained at the same time, during May or June; thus the effect of different weight of clothes at different seasons is eliminated. These data then represent height and weight for a cross-section of people at a given time.

The standards used for classification of persons according to underweight, normal, or overweight are included in tables produced by the Metropolitan Life Insurance Company: *Desirable Weights for Men Aged 25 and Over* and *Desirable Weights for Women Aged 25 and Over* (9). These tables take into account certain physical characteristics which result in variations in body weight and the range of desirable weights are shown at each inch of height for persons of slight, medium, and heavy build. Weights of those of medium build were used for all persons in the study in the Eastern Health District because of lack of information which would enable accurate classification as to type of build. Also, these tables make no distinction of age but apply to all persons 25 years or older.

Table 8 shows the distribution of males and females at specific ages according to their weight classification. Four weight classes are shown: "Underweight" 10 per cent or more below the standard used; "Normal" weight -9 to +9 per cent below or above the standard; "Overweight" from 10-29 per cent above the standard; and "Overweight" 30 or more per cent above the standard used.

AGE GROUP	TOTAL	UNDERWEIGHT 10 PER CENT OR MORE	NORMAL WEIGHT -9 to +9 PER CENT	OVERWEIGHT 10-29 PER CENT	OVERWEIGHT 30+ PER CENT
MALE					
20-24	100.0	14.0	56.0	29.3	0.7
25-34	100.0	7.1	48.9	38.7	5.3
35-44	100.0	3.7	41.3	44.9	10.1
45-54	100.0	4.3	40.7	45.0	10.0
55-64	100.0	6.6	44.6	35.6	13.2
65+	100.0	11.1	46.9	37.0	5.0
FEMALE					
20-24	100.0	29.4	38.1	21.9	10.6
25-34	100.0	20.9	34.1	29.4	15.6
35-44	100.0	9.3	25.9	37.6	27.2
45-54	100.0	3.7	15.8	37.3	43.2
55-64	100.0	5.3	17.7	38.5	38.5
65+	100.0	16.7	23.1	31.5	28.7

Table 8. Distribution of male and female persons at specific ages according to weight classes.

Among males the proportion classed as "Overweight" increased markedly up to age 54. After age 55 there was a slight decrease, the proportions varying from 42 to 49 per cent thereafter compared with 55 per cent at ages 45-54.

Females were similar to the males in that the proportion of overweight persons increased markedly as age increased. However, from 65 to 80 per cent of the females at ages 35 to 64 were classed as overweight compared with only 49 to 55 per cent of the males at those ages. Moreover, females showed a much greater tendency to very excessive overweight than did the males; that is, 30 per cent or more above the standard used. These data are shown in Column 5 of Table 8.

It may be that inability to take more precise consideration of the factor of variation in body build in relation to weight than was possible in this study may somewhat exaggerate the proportions of persons in the overweight classes. It will be recalled that weight for *medium* body build was used for all persons. However, it is believed that this procedure has not produced a serious discrepancy in the data presented.

CLASSIFICATION WITH RESPECT TO CHRONIC CONDITION	OBSERVED NUMBER	EXPECTED NUMBER	CHI-SQUARE	P
Both Overweight and Heart Disease	77	57.41	14.20	<.001
Heart Disease Only	37	56.68		
Overweight Only	1,130	1,149.60		
Neither Overweight nor Heart Disease	1,158	1,138.31		
Both Overweight and Hypertensive Vascular Disease	51	38.19	8.86	<.01
Hypertensive Vascular Disease Only	25	37.71		
Overweight Only	1,156	1,168.82		
Neither Overweight nor Hypertensive Vascular Disease	1,170	1,157.28		

Table 9. Observed and expected number of persons who were overweight and had a specific chronic condition.

It is of interest to present data which reveal the association of overweight with various chronic conditions. These data are based upon the records of 2,402 persons for whom a record of height and weight was obtained. The method of analysis is the same as that used to describe the association of specific chronic conditions in the same person. The classification "overweight" includes all persons 10 per cent or more above the standard used.

Table 9 shows the observed and expected number of persons who were both overweight and had heart disease and those who were both overweight and had hypertensive vascular disease. Both of these conditions were significantly associated with overweight. In both instances the observed number with both conditions was considerably greater than the number expected to be present if these conditions occurred at random in the population. Overweight and heart disease were both present in 77 persons compared with an expected number of 57. Both overweight and hypertensive vascular disease were present in the same person in 51 instances compared with an expected number of 38.

Table 10 shows the observed and expected number of persons who were overweight and who also had arthritis. Here again there was a statistically significant association of the two conditions in the same person as revealed by the chi-square

CLASSIFICATION WITH RESPECT TO CHRONIC CONDITION	OBSERVED NUMBER	EXPECTED NUMBER	CHI-SQUARE	P
Both Overweight and Arthritis	112	81.91	23.90	<.001
Arthritis Only	51	81.19		
Overweight Only	1,095	1,125.10		
Neither Overweight nor Arthritis	1,144	1,113.80		

Table 10. Observed and expected number of persons who were overweight and who had arthritis.

test. The observed number was 112 compared with an expected number of 82.

Both diabetes and gall-bladder disease occur with considerably greater frequency among females than among males. Both are believed to be associated with overweight. Table 11 shows the data for these two conditions among 1,249 females age 20 and over for whom a record of height and weight was obtained. The expected number of women who were both overweight and had diabetes was 10 compared with the observed number of 15. The chi-square value 4.6 indicates that the difference between the observed and expected numbers was beyond the limits of an expected or normal variation. Persons with diabetes are given instruction with regard to the importance of weight control. Since the data presented here are based upon the prevalence of diabetes in the population and include cases diagnosed a number of years before observation, the present association with overweight is of added significance (10).

Chronic gall-bladder disease was found to be associated with

Table 11. Observed and expected number of females who were overweight and who had a specific chronic condition.

CLASSIFICATION WITH RESPECT TO CHRONIC CONDITION	OBSERVED NUMBER	EXPECTED NUMBER	CHI-SQUARE	P
Both Overweight and Diabetes	15	10.12	4.60	<.05
Diabetes Only	3	6.87		
Overweight Only	728	732.91		
Neither Overweight nor Diabetes	503	499.10		
Both Overweight and Gall-Bladder Disease	26	17.86	9.37	<.01
Gall-Bladder Disease Only	4	12.12		
Overweight Only	717	725.17		
Neither Overweight nor Gall-Bladder Disease	502	493.85		

overweight among females. The chi-square value of 9.37 was higher than those obtained for hypertensive vascular disease and diabetes in relation to overweight.

It is apparent from the data presented here that examination of the experience of a cross-section of a sample population in the Eastern Health District of Baltimore confirms the impressions gained from the practice of clinical medicine. From their experience with patients, physicians have noted that patients with osteoarthritis are usually overweight, gall-bladder disease is usually more common in obese persons, diabetes is associated with obesity, and that hypertensive vascular disease is frequently associated with obesity.

Obesity may then be the predisposing factor which brings about the significant association of certain conditions in the same person. Heart disease and gall-bladder disease may be cited as an example. Study of the overweight population brings out this fact most strikingly.

Table 12 shows the observed and expected number of obese persons with both heart disease and gall-bladder disease and those with both heart disease and diabetes. It will be noted that the chi-square values 20.9 and 21.1 for the two classes of conditions, respectively, are slightly more than three times as high as those shown in Table 1 where the data are based upon the total population aged 20 and over. Thus the significance

Table 12. Observed and expected number of obese persons with multiple chronic conditions.¹

CLASSIFICATION WITH RESPECT TO CHRONIC CONDITIONS	OBSERVED NUMBER	EXPECTED NUMBER	CHI-SQUARE	P
Both Heart Disease and Gall-Bladder Disease	8	1.93	20.90	<.001
Heart Disease Only	83	89.13		
Gall-Bladder Disease Only	20	26.02		
Neither Heart Disease nor Gall-Bladder Disease	1,177	1,170.92		
Both Heart Disease and Diabetes	7	1.55	21.14	<.001
Heart Disease Only	84	89.52		
Diabetes Only	14	19.44		
Neither Heart Disease nor Diabetes	1,183	1,177.49		

¹ Obese persons are those 10 per cent or more overweight.

of the association of these conditions in the same person is greatly strengthened by study of the population classed as obese.

Table 13 shows the observed and expected number of obese persons with both hypertensive vascular disease and gall-bladder disease and those with both hypertensive vascular disease and arthritis. Here again the chi-square values are higher than those obtained by use of the total population. The values 7.4 and 8.2 are 31 and 75 per cent, respectively, above those shown for the same conditions in Table 3.

A comparison of persons classed as overweight and persons not overweight with respect to the number of cases of chronic conditions in each group is of interest. The chronic conditions to be considered include heart disease, hypertensive vascular disease, arthritis, diabetes, gall-bladder disease, and psychoneurosis. Among the persons classed as overweight there were 338 cases of these chronic illnesses; among the persons classed as not overweight there were 153 cases.

Table 14 shows the ratio of the actual number to the expected number of cases of chronic illness among 1,286 obese persons classified by broad age groups. The expected number for each age group was obtained by applying the prevalence

Table 13. Observed and expected number of obese persons with multiple chronic conditions.¹

CLASSIFICATION WITH RESPECT TO CHRONIC CONDITION	OBSERVED NUMBER	EXPECTED NUMBER	CHI-SQUARE	P
Both Hypertensive Vascular Disease and Gall-Bladder Disease	4	1.16	7.42	<.01
Hypertensive Vascular Disease Only	47	49.85		
Gall-Bladder Disease Only	24	26.79		
Neither Hypertensive Vascular Disease nor Gall-Bladder Disease	1,213	1,210.20		
Both Hypertensive Vascular Disease and Arthritis	10	4.38	8.22	<.01
Hypertensive Vascular Disease Only	41	46.62		
Arthritis Only	99	104.59		
Neither Hypertensive Vascular Disease nor Arthritis	1,138	1,132.41		

¹ Obese persons are those 10 per cent or more overweight.

AGE GROUP	ACTUAL NUMBER	EXPECTED NUMBER	RATIO OF ACTUAL TO EXPECTED
20-39 Years	38	34.66	1.10
40-59 Years	206	103.53	1.99
60+ Years	94	71.07	1.32

Table 14. Ratio of actual number to the expected number of cases of chronic illness among 1,286 obese persons, classified by age.

rate of chronic illness noted at that age for persons who were not 10 per cent or more overweight to the population composed of those considered as obese. At ages 20-29 the actual number exceeded the expected by 10 per cent. In the middle-age period, ages 40-59, the actual number of cases of chronic illness among obese persons was almost double the expected number. Even in the old-age group, 60 years or older, there was a marked excess in the actual numbers compared with the expected. It may be concluded from these data that obesity adds greatly to the risk of chronic illness, especially among persons of middle age or of old age.

SUMMARY

Data presented in this report indicate that certain chronic conditions occur with greater frequency in the same person than would be expected if such conditions were distributed at random in the population.

Those where the association of the two in the same person was found to be statistically significant are as follows: heart disease and gall-bladder disease, heart disease and diabetes, hypertensive vascular disease and arthritis, and psychoneurosis and gall-bladder disease.

Those where there was no statistically significant association in the occurrence of both in the same person are as follows: heart disease and arthritis, heart disease and varicose veins, arthritis and gall-bladder disease, arthritis and varicose veins, arthritis and diabetes, and arthritis and psychoneurosis.

The chronic conditions found to be significantly associated with overweight, 10 per cent or more above the standard used,

are heart disease, hypertensive vascular disease, arthritis, diabetes, and gall-bladder disease.

Study of the overweight population brought out the fact that obesity may be the predisposing factor which brings about the significant association of certain conditions in the same person.

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