

SUBCUTANEOUS FATNESS AND MORTALITY¹

By

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Obesity is so commonly associated with excess mortality in the minds of most physicians that it hardly seems surprising to find in a recent *Index Medicus* that the topic "obesity" is immediately followed by "obituaries". This association, which is not as solidly established as its general acceptance might indicate, stems largely from a long and impressive series of studies

by life insurance companies (1, 2, 3). Throughout this vast experience, the attribute of overweight was found to be strongly associated with excess mortality. But obesity is not the only cause of increased weight relative to height or body frame, and the correlation between obesity and excess weight is far from perfect, the correlation coefficient being of the order of 0.7 (4, 5). Thus it is clearly possible that fatness may or may not be the component of overweight responsible for its association with excess mortality.

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The evidence incriminating obesity is largely indirect, and to a considerable extent is based on observations involving change in weight. In the life insurance studies, it was found that overweight persons who achieved a normal weight did not experience excess mortality. And a study of U.S. Army officers indicated that there was an increased risk of disability and death, mainly from cardiovascular-renal diseases of a degenerative type, associated with weight gain during adult life (6). In both situations, it seems likely that change in weight was caused by changes in body fat. Although a more recent study failed to confirm the pattern of excess deaths among overweight persons (7), this observation does not absolve fatness, for the population under study consisted of California longshoremen, whose work may well be suffi-

ently strenuous that their excess weight does not result from obesity.

Direct evidence on the relationship of obesity to mortality would obviously be highly desirable. Unfortunately, the measurement of total body fat is a difficult procedure and not yet adapted for studies of large populations. Most investigators have had to base their estimates of obesity on subcutaneous fat, measured either by skinfold calipers or from roentgenograms (8). The latter method was employed in the present study to classify a general population of more than 24,000 persons by degree of subcutaneous fatness, and to relate this characteristic to mortality during a subsequent period of nearly 15 years.

MATERIALS AND METHODS

In May and June, 1946, a community-wide survey was conducted in Muscogee County, Georgia for the purpose of detecting cases of syphilis and tuberculosis. Following this, on September 1, 1946, a census of the county was conducted (9). Matching the records from the survey and census showed that about half of the census population 15 years of age or older had received 70 millimeter chest photofluorograms during the survey.

In 1961, these photofluorograms were used for measurements of the combined skin and subcutaneous fat layers over the chest wall (10). The image of the film, enlarged to full size, was projected on a white cardboard screen in a darkened room. It was identified only by number. Four sites were selected for measurement—two "flank sites" at the level of the costo-phrenic angles, and two "trapezius sites" at the mid-points of the trapezius ridges. All measurements, except for a few hundred by one of the authors (GWC), were made

by clerks after a short training period. A series of 100 consecutive photofluorograms was used for determinations of the degree of precision attained by the readers. Comparisons of results obtained by different readers initially and during the period of measuring photofluorograms showed a high degree of agreement, both with their own readings and those of others. For example, the readings of a clerk who made about half of the measurements for this study were compared at the end of initial training and after several weeks of experience. The average deviation between the two sets of readings of the 100 consecutive films was 0.1 millimeter with a standard error of 1.2 millimeters. Comparisons of the 100 films by this clerk with those of the clerk who made the next largest number of readings, both after several weeks of experience, showed an average deviation of 0.2 millimeter with a standard error of 0.7 millimeter. In both instances, there was only a slight tendency for the deviations to increase as the thickness of the fat layer increased.

Because subcutaneous fat shadows were more often measurable at the trapezius site than at the flank site, and because measurements at the two sites were highly correlated, estimates of subcutaneous fat for this study were restricted to the trapezius site (10). In almost all instances, the fat layer measurement used in this study is the average of the right and left sites: when only one site could be measured, that measurement alone was used.

Not all of the original survey photofluorograms could be measured. Several rolls had deteriorated with age to the extent that they were unreadable. Improper exposure or positioning of the subjects was also an important source

of loss, as was the inability to read the identification number on the film. Fortunately, these losses appeared to affect the surveyed population haphazardly. Of greater concern were the persons whose subcutaneous fat layers could not be measured because the external borders of the chest wall fell outside the limits of the fluorescent screen. Persons with very large bony chests are not represented in this study, nor are those with bony chests of average size but with extremely thick soft tissue. Some persons were also excluded for reasons not directly associated with this phase of the study, namely because measurements of the heart or bony thorax could not be made.

Finally, the study population was restricted to persons over 15 years of age in 1946. Of the 69,651 persons over this age and enumerated in the census, 24,390 or 35 per cent had satisfactory measurements of both the subcutaneous fat layer at the trapezius site and the bony thorax. The proportion of the total population included in the study varied with race, sex and age (10). Negroes were better represented than whites, and females better than males. Adolescents and persons of middle age were more likely to have been examined than young adults or the elderly.

Death certificates for all persons dying in Muscogee County from 1946 through 1960 and for Muscogee County residents dying elsewhere in Georgia have been matched against the combined census-survey records, thus identifying residents with measured photofluorograms who died within the state. Causes of deaths occurring from 1946 through 1949 had been coded by one of the authors (MAK) in 1949 according to the 5th Revision of the International Lists of Diseases and Causes of Death.

Later deaths were coded by the Georgia Department of Public Health according to the 6th and 7th Revisions. For deaths of Muscogee County residents occurring outside the state, a punched card was returned to the county in lieu of the death certificate. Although the identification data on the card was less extensive than that on the certificate, most out-of-state deaths of Muscogee County residents occurred in Russell County, Alabama, where the Health Department files contained the missing information. Certificates were not obtained for the remaining deaths but the matching failures resulting from this omission have been too few to be important.

The examined resident population decreased during the study period not only because of deaths but also because of removals from the county. To estimate losses from emigration, the residence status of a 2 per cent sample of the population was investigated in 1954 (11) and again in 1961. Because of the small numbers of older people in the original sample, the 1961 sample was expanded by adding 236 persons who were more than 55 years of age in 1946. They were selected systematically to provide approximately 60 persons of each race and sex, divided equally between the 3 categories of subcutaneous fatness.

RESULTS

During the observation period of 14 $\frac{1}{2}$ years, it is estimated that almost a third of the study population moved away. The pattern of emigration is summarized in table 1. For each race, approximately the same proportion of males and females left the county. Losses were greater for whites than for Negroes, and considerably greater for young adults than for older persons. The excess emi-

gration of young adult whites may reflect the fact that Muscogee County is adjacent to a large Army post which in 1946 was staffed almost entirely with white troops. The most important finding in the context of this study, however, is that fat people were least likely to move away.

The estimated mid-point population is shown in table 2, adjusted for known deaths and estimated losses from emigration. In spite of the fact that the initial population comprised more than 24,000 persons, numbers in some of the individual cells are small. To some extent, these small numbers are offset by a relatively long period of observation. For example, although there were only 27 Negro males in the oldest and fattest group at the mid-point date,

TABLE 2
Estimated mid-point study population by race, sex, age and subcutaneous fatness in 1946

Age in 1946	Trapezius fat thickness in mm.							
	Total	0-4	5-9	10+	Total	0-4	5-9	10+
	White males				White females			
Total	4759	1951	2177	631	7142	1709	3652	1781
15-34	2333	1221	911	201	4017	1199	2137	681
35-54	1944	573	1019	352	2602	430	1277	895
55+	482	157	247	78	523	80	238	205
	Negro males				Negro females			
Total	3060	1648	1170	242	4704	1118	2133	1453
15-34	1583	973	532	78	2753	751	1316	686
35-54	1229	561	531	137	1637	297	684	656
55+	248	114	107	27	314	70	133	111

TABLE 1
Emigration between September 1, 1946 and July 1, 1961 in a sample of the study population by race, sex, age and subcutaneous fatness in 1946

Characteristic	Number in sample	Per cent moved out of county*
Total	700	30
<i>Race-Sex</i>		
White males	155	32
White females	241	35
Negro males	127	23
Negro females	177	26
<i>Age in 1946</i>		
15-34	262	38
35-54	168	22
55+	270	12
<i>Trapezius fat thick- in 1946</i>		
0-4 mm.	235	35
5-9 mm.	296	30
10+ mm.	169	20

* Percentages adjusted to race-sex-age composition of examined population.

these men represented an experience of nearly 400 person-years.

The overall relationship of subsequent mortality to fatness over the trapezius ridge in 1946 is shown in table 3 and figure 1. The mortality ratios have not only been adjusted for population losses, but also for differences in race, sex and age composition of the three fatness groups. As indicated in table 3, the mortality experience of each group regardless of fatness is accepted as the standard rate. This is applied to the estimated mid-point population for each fatness category to give expected numbers of death if fatness were not associated with mortality. The ratio of observed-to-expected deaths for each fatness group, expressed as a percentage, is the mortality ratio used throughout this paper. Percentages above 100 thus signify an excess of observed over expected deaths. Mortality from all causes was lowest in the group with a trapezius fat layer of 5-to-9 millimeters, slightly

TABLE 3
Standardized mortality ratios for selected causes of death, by thickness of subcutaneous fat in 1946*

Cause of death	International classification code numbers†	Subcutaneous fat in mm.			
		Total	0-4	5-9	10+
Total		100	98	96	112
Cardiovascular-renal		100	91	97	118
Coronary heart disease	420	100	91	89	137
Strokes	330-334	100	94	97	114
Hypertension	440-447	100	98	95	113
Other	400-416, 421-434, 450-468, 592-594	100	83	113	98
Diabetes	260	100	55	92	162
Accidents	800-962	100	82	106	126
Cancer	140-203	100	106	93	108
Tuberculosis	001-019	100	174	70	28
Other respiratory diseases	241, 480-493, 502, 525-527	100	117	104	64

* Standardized for race, sex and age in 1946.

† International Lists of Diseases and Causes of Death, Sixth Revision.

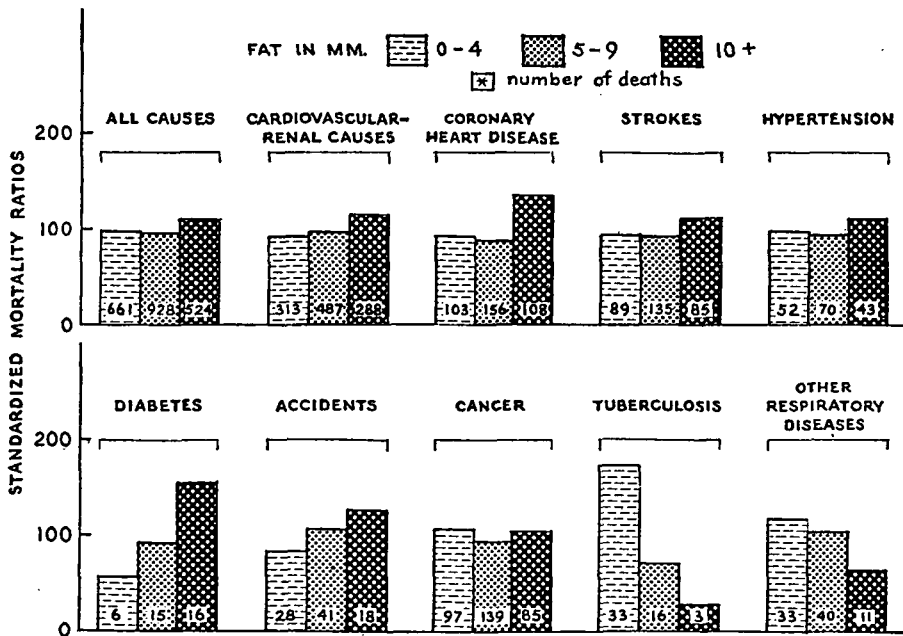


FIGURE 1. Standardized mortality ratios and numbers of deaths for selected causes of death, by thickness of subcutaneous fat in 1946.

higher in persons with a fat layer less than 5 millimeters thick, and about 12 per cent higher in persons with 10 or more millimeters of subcutaneous fat.

The association of mortality with fatness was somewhat more marked for deaths ascribed to the group of cardiovascular-renal diseases. An even more marked correlation was found for coronary heart disease, the mortality ratio for the fattest group being about 40 per cent higher than for the other two groups combined. Excess mortality from strokes and hypertension among fat persons was similar and less marked than for coronary heart disease. For all of these major cardiovascular causes—coronary heart disease, strokes, and hypertension—there was little difference in the mortality ratios for persons with 5-to-9 millimeters of subcutaneous fat and those with less than 5 millimeters. Only the fattest groups showed a significant increase in mortality. The residual cardiovascular-renal causes of death did not show the same relationship with fatness: for this group, the highest mortality ratio was noted among persons with intermediate fatness. The importance of this observation is obscured by the mixture of diagnoses lumped together in this category.

The most marked positive correlation with fatness was noted for diabetes deaths, the mortality ratio for the fattest group being almost three times that for the leanest. Accidental deaths were also associated with degree of fatness. The association was not as marked as for diabetes or coronary heart disease, but more marked than for any other major cause.

A negative association with subcutaneous fatness was found for only two categories—tuberculosis, and a group of other respiratory diseases which in-

cluded asthma, chronic bronchitis, emphysema, influenza and pneumonia. For tuberculosis, the trend of the mortality ratios was striking, being nearly seven times higher in the thinnest group than in the fattest. The group of other respiratory diseases showed a definite negative association but not nearly so marked as that for tuberculosis.

No trend was noted for cancer deaths nor for the residual category of all other diseases. In both, the mortality ratios were slightly lower for persons of intermediate fatness and almost the same for the thinnest and fattest groups.

Among the various race-sex-age groups, there was considerable variation in the relationship of fatness to mortality. The ratios for all causes of death are shown in table 4 and figure 2. The most marked association of fatness with excess mortality occurred among young adult white males. The correlation was much less marked for those of middle age, while for white males over the age of 55 years, the thinnest persons had a slightly (but not significantly) worse prognosis than the others. The situation for white females was different. For the youngest group, persons of intermediate fatness experience the lowest mortality. For white females past the age of 35, mortality was greatest among women with the most subcutaneous fat. Among Negroes, the association of fatness with mortality was irregular among the various sub-groups. For young females and older males, mortality was somewhat excessive among fatter persons. For middle-aged Negroes of both sexes, total mortality was lowest in the group of intermediate fatness.

Mortality ratios for all cardiovascular-renal causes, shown in table 4 and figure 3, exhibited a somewhat similar pattern to that observed for all causes

TABLE 4
Mortality ratios for selected causes of death by race, sex, age and thickness
of subcutaneous fat in 1946

Age in 1946	White males			White females			Negro males			Negro females		
	Thickness of subcutaneous fat in mm.											
	0-4	5-9	10+	0-4	5-9	10+	0-4	5-9	10+	0-4	5-9	10+
All Causes												
Total*	95	99	113	104	92	109	101	96	112	104	92	108
15-34	61	132	188	135	64	152	91	117	98	85	79	121
35-54	98	97	121	89	101	104	113	83	112	124	83	106
55+	108	96	96	94	96	106	88	109	116	95	102	100
All Cardiovascular-Renal Causes												
Total*	92	102	111	102	82	123	95	103	110	90	92	115
15-34	48	129	286	143	53	167	60	168	133	45	102	157
35-54	90	99	120	69	94	124	109	90	103	121	84	108
55+	99	103	93	116	78	119	85	111	121	76	99	116
Coronary Heart Disease												
Total*	95	93	131	71	72	149	91	105	119	105	74	128
15-34	38	128	349	—†	—	—	—	—	—	61	88	167
35-54	99	87	141	47	78	157	96	80	194	129	49	140
55+	102	99	99	98	65	142	92	134	0	105	111	83
Strokes												
Total*	89	117	67	130	83	108	105	94	103	75	87	129
15-34	—	—	—	—	—	—	—	—	—	67	75	185
35-54	71	125	75	65	129	77	114	92	74	103	100	99
55+	104	110	61	163	55	127	101	83	167	52	77	158
Cancer												
Total*	100	93	123	109	93	106	112	88	91	113	94	99
15-34	—	—	—	128	58	182	—	—	—	70	110	115
35-54	118	86	112	114	88	110	119	91	54	100	98	102
55+	105	92	115	79	123	82	94	83	200	200	66	78

* Adjusted for age.

† — Signifies less than 10 deaths for age-group.

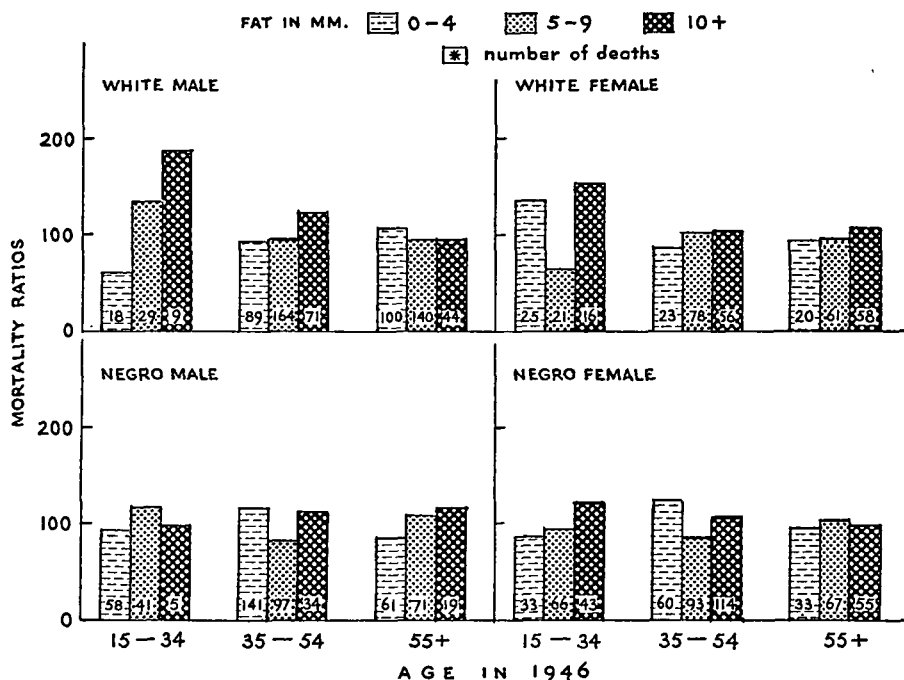


FIGURE 2. Mortality ratios and numbers of deaths for all causes of deaths, by race, sex, age and thickness of subcutaneous fat in 1946.

of death, but in almost all race-sex-age groups the association with fatness was more marked. The only exceptions to the general pattern of greatest mortality among fattest persons occurring among old white males, and middle-aged Negroes of both sexes.

For coronary heart disease, the association of fatness with mortality was even more marked than for all cardiovascular-renal causes combined. However, as can be seen in table 4 and figure 4, the numbers of deaths were small in all subdivisions except for white males over the age of 35. Perhaps the most striking finding was the continued absence of an association of mortality with fatness among the oldest white males.

Mortality ratios for strokes are shown in table 4 and figure 5. Although there was a somewhat increased risk for the

fattest people when all race-sex-age groups were combined, the pattern for individual subgroups showed no consistency.

Cancer mortality ratios are given in table 4 also, and illustrated in figure 6. In only one of the race-sex-age groups was mortality greatest among persons with intermediate fatness, but no other consistent pattern could be noted.

Deaths from other individual causes were too few to warrant examination by race, sex and age. For tuberculosis and diabetes, the patterns revealed by the experience of the total study group were found with considerable consistency in the subdivisions in spite of the small numbers. For other respiratory diseases and accidents, the mortality ratios by race, sex and age showed generally the same pattern as observed for the total group, but less consistently than for

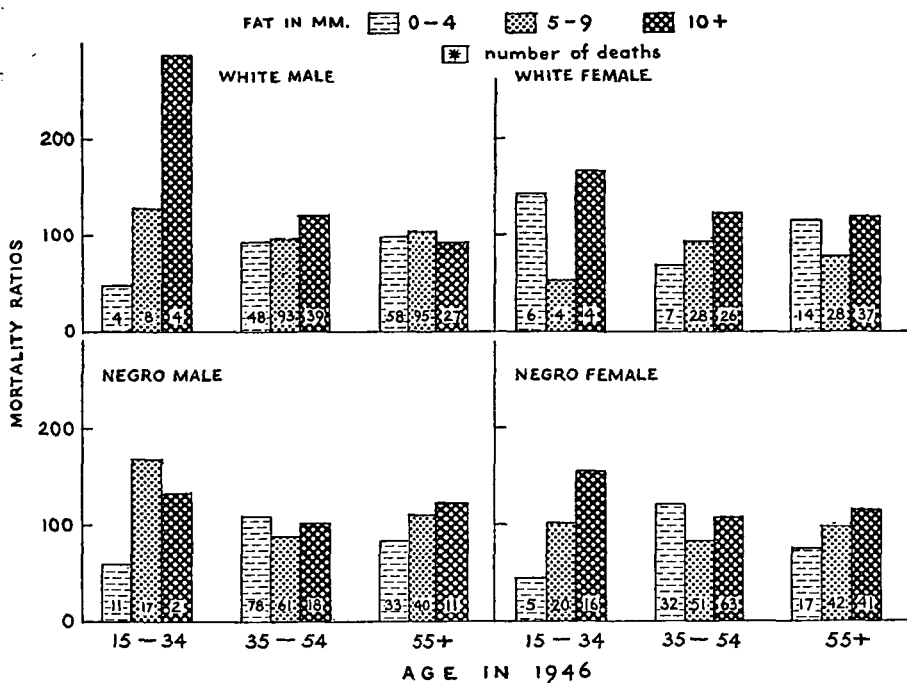


FIGURE 3. Mortality ratios and numbers of deaths for all cardiovascular-renal causes of death, by race, sex, age and thickness of subcutaneous fat in 1946.

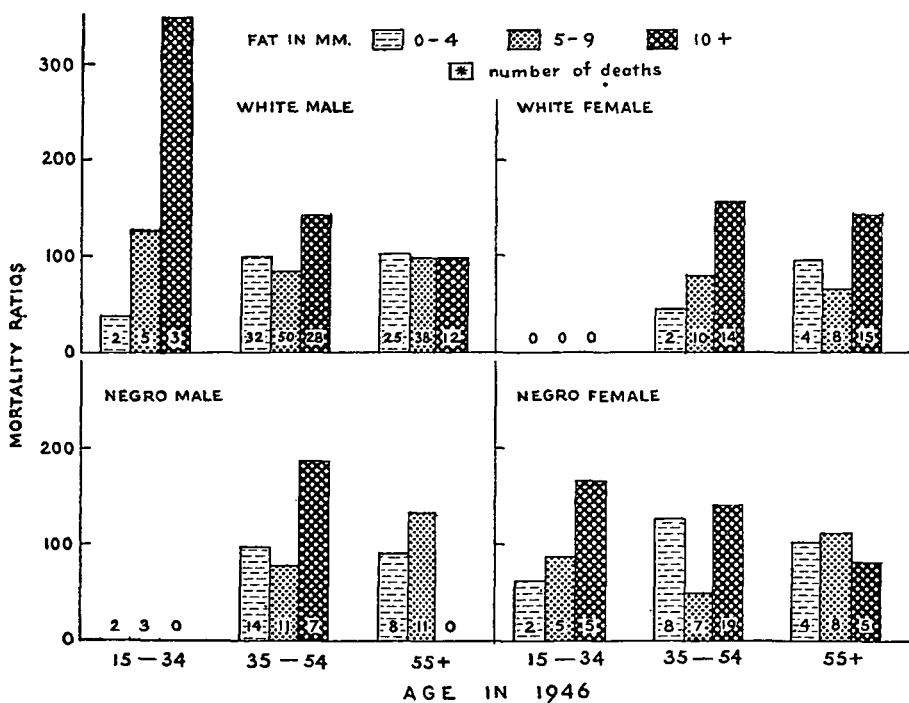


FIGURE 4. Mortality ratios and numbers of deaths for coronary heart disease, by race, sex, age and thickness of subcutaneous fat in 1946.

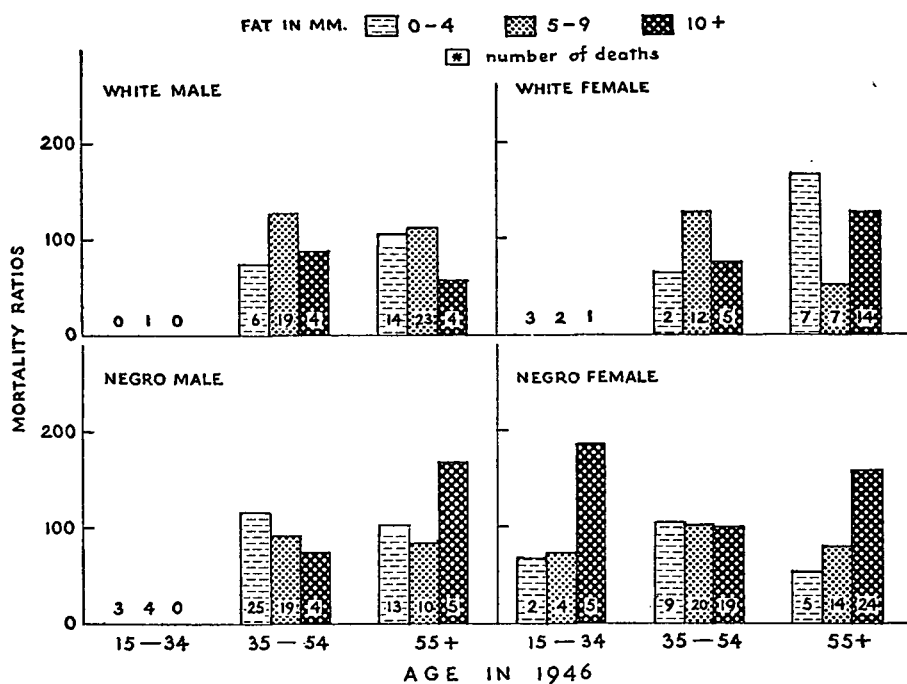


FIGURE 5. Mortality ratios and numbers of deaths for strokes, by race, sex, age and thickness of subcutaneous fat in 1946.

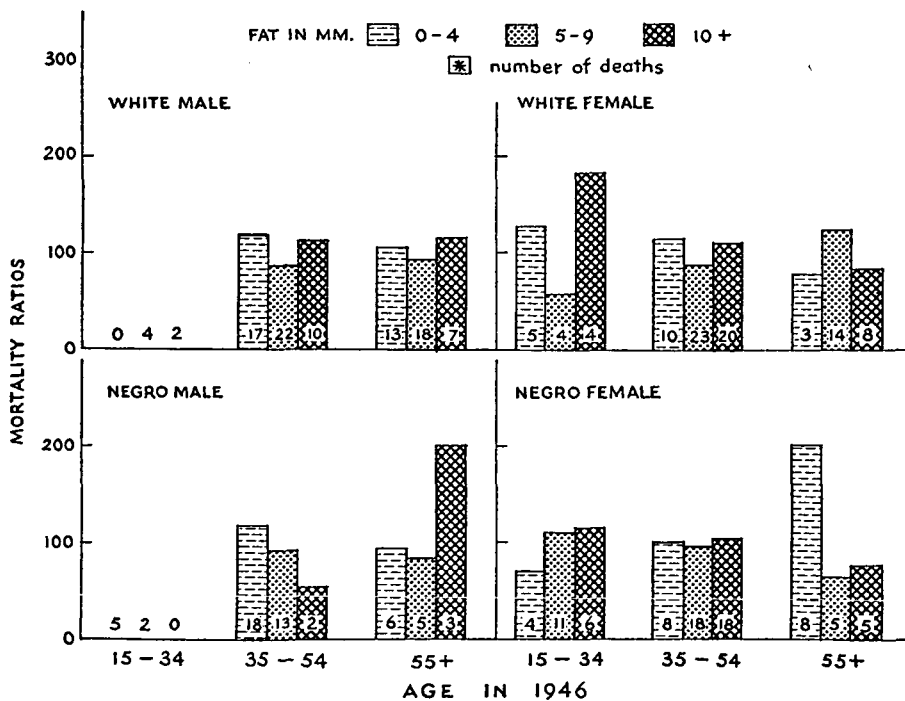


FIGURE 6. Mortality ratios and numbers of deaths for cancer, by race, sex, age and thickness of subcutaneous fat in 1946.

tuberculosis and diabetes. Although there were only 18 deaths ascribed to hypertension in the youngest age group, these were heavily concentrated among the fattest persons. At other ages, fatness and hypertensive deaths did not appear to be associated.

DISCUSSION

In assessing the significance of these results, a fundamental consideration is the extent to which subcutaneous fat over the trapezius ridge is a meaningful parameter of obesity. Information on this point is still incomplete. Garn made fat measurements at 12 different subcutaneous sites on 100 young adult white males (12). Of the various sites, those over the pelvis were the best predictors of subcutaneous fatness in general and also of body weight, but the lower lateral thoracic site was almost as satisfactory. In the present study, a high correlation was noted between subcutaneous fat over the lower lateral thorax and over the trapezius ridge. Therefore, the latter may also be at least a fair index of subcutaneous fatness in general.

Although the proportion of subcutaneous to visceral fat is not necessarily constant between individuals nor at different ages, it has been reported that increased fatness with age is reflected in thicker skinfolds (13). And change in weight among adult males, while not correlated with skin-fold thickness over the forearm, was positively associated with subcutaneous fatness at three other sites—over the triceps muscle and at two thoracic areas (14). In addition, change in weight among a small group of females has been shown to be reflected in the thickness of subcutaneous fat in many areas of the body, including the trapezius ridge (15). On the basis of

these limited observations, and on general grounds as well, it seems reasonable to accept subcutaneous fat over the trapezius ridge as an indicator of general obesity. Furthermore, and not unimportantly, it is a readily available index which can be obtained in a reproducible and unbiased manner (8, 10).

An unequivocal, though somewhat insensitive, index of the effect of fatness on health was afforded by total mortality. Although further analysis of specific causes of death is subject to many problems of diagnosis and nosology, these problems are probably less serious in Muscogee County than in many areas of the country. Columbus, the principal city of Muscogee County, has become a regional medical center of some importance in recent years. An indirect but perceptive clue to the high caliber of the community's medical resources is the fact that its major hospital has had a full complement of interns and residents during the last 10 years of the study period.

Even with satisfactory indices of attribute and effect, it is still necessary to be assured that ascertainment of the effect is not biased. In studies by the life insurance companies of the relationship of weight to mortality, reporting of deaths was almost certainly complete, and hence unbiased. For the present study population, complete reporting of mortality could safely be assumed only for those who remained in the county, making it necessary to obtain some measure of emigration and its relationship to fatness. Fortunately, one of the many studies conducted in this population had already ascertained the residence status of a two per cent sample (16). Contrary to initial expectations it was found that there was differential emigration and that fat persons were

more likely to remain in the county than lean persons. An indication that this finding is not unique is found in a recent case-control study of coronary heart disease in North Dakota (17). Among the controls who were 30 per cent or more overweight, 63 per cent were "stable" geographically and occupationally; only 44 per cent of lighter persons were so classified.

Consideration should also be given to survey participants who were excluded from this study. Persons whose films or identification numbers were not readable cause little concern. Their exclusion appears to have been haphazard and almost always unrelated to any parameter of body build. But in addition to a readable film and identification number, each member of this study population had to have measurements of the following: subcutaneous fat over at least one trapezius ridge, transverse diameters of the chest and heart, and the distance between the posterior portions of the first and tenth ribs. Very few persons were excluded because the last two measurements were lacking. Some were excluded because of severe spinal deformity, or technical failures, such as poor positioning. Many of the exclusions, however, appeared to be the result of bony thoraces so large or soft-tissue layers so thick that the outer margins of the chest extended past the limits of the fluorescent screen and hence were not visible on the film.

The exclusions should thus be weighted with unusually fat persons, and it would be anticipated that their experience might most closely resemble that of the fattest group among the measured population. This expectation was borne out. The emigration rate for persons excluded because of incomplete measurements was almost identical with that

for the fattest group, and their total mortality was somewhat higher.

Some of the relationships of fatness to mortality might have resulted from the effect of disease upon fatness. The study population was not examined thoroughly to be certain that no manifest disease was present when the photofluorograms were taken. It is thus possible that the disease from which the person ultimately died might have influenced the degree of fatness directly, or indirectly through dietary or other therapeutic measures. Three factors tend to minimize these influences. The survey photofluorograms were made in May and early June of 1946, and the follow-up study of mortality did not start until the census date of September 1, 1946. To participate in the survey required that the person be ambulatory, thereby excluding most persons with serious illnesses at that time. Finally, the length of the follow-up period—more than 14 years—makes the effect of disease on fatness less important than it would be for a short-term observation period. Nevertheless, the association of tuberculosis with fatness was probably influenced to some extent by the presence of disease at the survey examination. In addition to its chronicity and its tendency to cause weight loss, most tuberculosis deaths, because of effective chemotherapy after 1949, occurred early in the follow-up period. The relationship of other causes of death to fatness was, in our opinion, little affected by disease conditions existing at the time of the survey examination.

Studies which may most reasonably be compared with the present one are those conducted among life insurance policy holders and among California longshoremen (1, 2, 3, 7). A major difference has been that these previous

studies have related mortality to overweight, and not to subcutaneous fatness. Generally speaking, the life insurance studies found a pattern of mortality and relative weight very similar to that found for fatness both for all causes and for the major individual causes of death. With the passage of time, the excessive mortality among underweight persons noted in the early studies has disappeared, apparently almost entirely the result of the declining importance of tuberculosis as a cause of death. And where the early study (1) showed greater excess mortality among older overweights, a recent life insurance study (3) showed greater excess mortality among younger overweight persons.

For both of the preceding studies, age groups were quite broad. An intermediate report (2) used finer age groupings, and showed that overweight white males aged 50-to-64 years on entry had a mortality experience which, while still excessive compared with light persons, was much less marked than that for younger persons who were equally overweight. Furthermore, for this older group, there was no increase in excess mortality with increasing degree of overweight. The absence of a gradient of mortality with increasing overweight for old white men is the only confirmation among the life insurance studies for the observation that there was no excess mortality associated with fatness among white males over the age of 55 years in Muscogee County. This finding raises questions about the relationship of obesity to mortality, and the possible mechanisms that might be involved.

Among the California longshoremen aged 45 years and over, there was also no indication that mortality was related to overweight (7). Their occupa-

tion suggests regular strenuous physical exertion, and it is possible that overweight in this group is not caused by obesity. Another explanation might be that physical exercise protects in some way against the adverse effects ordinarily associated with overweight. In the present population, the proportion of white males who were examined at their place of employment increased with age (9). But although it is possible that physical exercise associated with industrial employment may have had a beneficial effect, it does not seem likely to have been a major factor in the lack of excess mortality among fat old white men in Muscogee County.

A prospective study among male Civil Service employees in California noted similar associations of overweight with incidence of coronary disease by age to those noted in this study for subcutaneous fatness with mortality from coronary heart disease (18). Below the age of 50 years, there was a marked increase in the rate of new coronary heart disease with increasing weight; over this age, the risk was very similar for all 3 weight groups, being slightly higher for persons of intermediate weight. Even when adjustments were made for differences in blood pressure and serum cholesterol, overweight was associated with an increased risk of coronary disease for men under the age of 50 but not for older men.

The fact that there are many similarities in the patterns of mortality related to subcutaneous fatness and to relative weight does not signify that fatness is necessarily the only component of overweight which bears directly or indirectly on subsequent mortality. Overweight can result from deviations from normal body build other than the proportion of fat. The relative importance of the fat and non-fat

factors contributing to overweight must be assessed from populations in which both factors can be measured. Unfortunately, because information on height and weight was not collected in this community survey, relative weights of the participants in the study are not known.

It was previously noted that the median thickness of fat showed little change after the age of 35 among men in Muscogee County whereas among females, fatness increased until the age of 50, and diminished thereafter. The patterns for whites and Negroes were similar (10). The question was raised whether differential mortality among fat and lean persons might explain this variation of subcutaneous fat with age. Among the youngest age groups, the death rates have been too low to have had much effect on survivorship even though rates among fat persons were relatively excessive. Among the oldest age groups, the death rates were clearly high enough to produce a marked effect upon the median thickness of subcutaneous fat, if there were appreciable differences in the mortality of fat and lean persons. For whites, this is a possible explanation for the pattern of fatness with age. Among old white males, fatness was not associated with excess mortality, and median fatness did not change with age. Among old white females, mortality was greater for the fattest group, and median fatness showed a marked decline with advancing age of the population. Unfortunately, the experience of the oldest Negroes does not fit this neat explanation. Males had excess mortality associated with fatness, but no decrease of fatness with age in the population, whereas females had no evidence of excess mortality associated with fatness, but did show

a decrease in median fatness with advancing age very similar to that for white females. It is obvious, therefore, that excess mortality associated with fatness is not the only determinant of the prevalence of obesity in the older population.

The present study may also have an indirect bearing on the problem of smoking and health. An oft-heard reason for continuing to smoke cigarettes is the fear of gaining weight when smoking is discontinued, usually with the implication that the risk to life from obesity is equal to or greater than the risk from smoking. The available data do not bear this out. In a special report to the Surgeon General's Advisory Committee on Smoking and Health, Hammond reported mortality ratios for men over 40 years of age (19). The excess mortality associated with cigarette smoking was considerably greater than that associated with fatness in the present study for white males of similar age. The combined findings suggest that it is probably safer to reach for a sweet instead of a cigarette.

SUMMARY

Subcutaneous fat over the trapezius ridge was measured from the chest photofluorograms of 24,390 residents of Muscogee County, Georgia who had participated in a community survey for tuberculosis in 1946. The proportion of these persons remaining in the county was estimated by determining the residence status of a sample of the population. Mortality from 1946 to 1961 was ascertained by matching death certificates of Muscogee County residents with the records of persons examined in the survey.

Emigration was more marked for whites than for Negroes, similar for

males and females, and more marked for young than for old adults. Thin persons were more likely to move away than fat persons.

For all race-sex-age groups combined, mortality over a period of 14½ years was about 12 per cent greater for the fattest persons. Mortality from diabetes was most strikingly associated with fatness, followed in order by coronary heart disease, accidents, strokes and hypertension. Tuberculosis and other respiratory diseases showed the opposite trend, thin persons having greater mortality than fat persons. No relationship with fatness was noted for cancer and the residual causes of death.

The association of fatness with mortality was not the same for all race-sex-age groups. Excessive mortality among fat persons was generally more marked for whites than for Negroes. A major exception was the experience of white males over the age of 55 among whom fatness was not associated with increased mortality.

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