THE TREND OF OBESITY IN THE USA

by

P. V. Sukhatme
Food and Agriculture Organization, Rome

1. INTRODUCTION

The importance of controlling obesity for the health of man in the middle and later age groups is now fairly well recognised. While hereditary factors may contribute to the incidence of obesity in the population, overeating and under exercise are also among the important factors influencing it. The purpose of this paper is to study the incidence of obesity and its likely trend in the context of growing mechanization, keeping in mind the trends in food supply and population growth.

2. OVERNUTRITION

In an affluent society food supply exceeds very considerably the food needed to maintain a healthy active life. This is demonstrated by the data in Table 1. The Table shows that as against a calorie requirement of 2600 per caput per day, the calorie supply available during 1954/56 was of the order of 3200, thus exceeding requirement by about 20%. The Table also shows that during 1964/66 the calorie supply remained more or less the same as in 1954/56, but owing to a downward revision of calorie requirement in 1964 consequent on the changed pattern of activity, the excess of supply over requirement further increased, being 33%. This excess is seen to occur in all income groups (vide Table 2) and shows that there is no insufficiency of calories in the USA, even in the poorest classes.

Much of the excess supply must clearly be ascribed to waste which appears to be more than the 10% allowed for in estimating requirement at retail level from that at the physiological level. But there can be no denying that an excess supply as large as that shown in Tables 1 and 2 must favour overeating. This is amply borne out by the data on food consumption collected during the nationwide household surveys in 1955 and 1965 and presented in Table 3. As the Table shows, in 1955 three out of every four households had a calorie supply per nutrition unit exceeding 3500. This proportion was even higher in the year 1965 being four out of five. This does not however mean that the population covered by three out of every four households in 1955 or four out of every five households in 1965 can be regarded as overnourished any more than the population covered by one out of every four in 1955 or one out of every five households in 1965, which is found to fall short of the corresponding requirement, can be considered to be undernourished. Clearly some people will need less than the stipulated average calorie requirement while others may need more depending upon the extent to which the different individual factors, including physical activity, deviate from those of the 'reference' man. The only way of estimating the incidence of overnourished in the population is to evaluate o given by

$$o = \int_{\frac{x}{y} > 1} f\left(\frac{x}{y}\right) d\left(\frac{x}{y}\right)$$

where x represents the calorie intake, y the corresponding requirement and $f(\frac{x}{y})$ the distribution function of calorie intake relative to requirement of individuals in the population. Unfortunately, there is no information available on the distribution function $f(\frac{x}{y})$ for individuals. The available nationwide data collected during 1955 and 1965 related to intake of households per nutrition unit and not individuals. We can however approximate to the expression o by evaluating o' given by

$$o = \int_{\bar{x} \geqslant c - 3\sigma_{\bar{y}}} g(\bar{x})\, d(\bar{x})$$

where $\bar{x}$ = calorie intake of the households per nutrition unit

$\bar{y}$ = calorie requirement of the household per nutrition unit*

c = calorie requirement of the 'reference' man

and $\sigma_{\bar{y}}$ = standard deviation of $\bar{y}$

Available data show that the standard deviation of energy expenditure among healthy active adults of the reference type is roughly 500. Since the average size of the household is approximately 2.5 nutrition units, we may conclude that $\sigma_{\bar{y}}$ is roughly 300.

Clearly in a well-fed society we would have expected most households in 1955 to have had calorie supplies per nutrition unit between two limits $3500 \pm$ three times 300, that is 2600 and 4400. If we use the revised recommendations of the Food and Nutrition Board (1964) this range would be 2300 to 4100.

In actual fact, as Table 5 shows, a large proportion of the households is seen to have a calorie intake exceeding the limits given above. It would appear that the proportion of overnourished approached 50% in 1955 and if anything has further increased in 1965 to 57%. It is of course

possible that the calorie supply available for consumption has been overestimated since much more food is probably wasted than has been allowed for. It is also possible that the requirement is underestimated in the sense that the average of energy expenditure on the physical activities of a person does not correspond to the level of moderate activity visualized for the reference man. Even with these errors the evidence appears conclusive that nearly half of the population in the USA, is overeating and that, if anything, the incidence of overnutrition in the population is increasing.

3. TRENDS OF ENERGY EXPENDITURE RELATIVE TO INTAKE

That food supply exceeds needs is easily verified by the many obese people we see everywhere in the advanced countries. Available evidence shows that the obese on average eat no more than non-obese persons of comparable age and occupation. It follows that obese people must be physically less active and spend less energy than the non-obese. If then we can ascertain the rate of energy expenditure and its trend during daily occupations we should be able to infer the trend of obesity as well. The best way is to study the data of surveys of physical activity of working populations, but such surveys are difficult to organize (Passmore 1962). In the absence of data for such surveys we can only attempt an indirect and rough assessment of the extent of reduction of energy expenditure by analysing the shift in the pattern of occupations and reduction in working hours of the working population for countries for which such data are available.

A glance at Table 4 on the classification of employed persons by occupation shows that there is a significant shift in the USA in the pattern of occupation since 1950 (US Department of Commerce, 1966). Thus, whereas in 1950 white collar workers accounted for about 37% of the total employed persons, they now exceed 44% of the total, thereby suggesting that more people are now engaged in activities which require less energy than that needed by the average adult worker. The decrease over the same period in the proportion of people employed in occupations requiring relatively larger energy expenditures supports this trend, e.g., whereas over 18% of the working force in 1940 was employed on farm work, such workers currently form only 6% of the total employed. The shift shows that energy expenditure per adult of the working population must have decreased over the last 15 years. Using known rates of energy expenditure of physical activity in different occupations and regrouping them into white collar, blue collar, service and farm workers, as shown in Table 4, we estimate that the energy expenditure on work in daily occupations has decreased by about 0.5 calories per minute on 8-hour working time, or roughly by 200 to 300 calories per day. It is likely that over and above this reduction more power has become available to replace in part the manual work done in 1950. It is also likely that with industries and workshops already mechanized in 1950 a further reduction on this gain may not be significant in the case of the USA. On a conservative basis we may say that the daily energy expenditure of the adult population on work in employment appears to have decreased at the rate of roughly 15-20 calories per annum. The revision of the calorie requirement scale announced by the Nutrition Committee of the USA, reducing the requirement of the 'reference' man and woman by 300 and 200 calories respectively, accords with these findings (Food and Nutrition Board, 1964).

While food requirements have undoubtedly decreased, available evidence indicates that the trend and pattern of food supply available for consumption in the USA has also changed over the last 15 years (FAO, 1963, 1966). However, the reduction in calorie supply appears to be of a smaller order (Table 5). The Table shows that the daily calorie supply per caput has remained steady or has gone down only slightly. What we need, however, is not the trend in per caput food consumption but the trend in food consumption of the adult population employed in work. An approximate estimate of this latter trend can be obtained by adjusting the data for food consumption per caput of total population by allowing for the physiological needs of children and old people in accordance with the recommendations of the Calorie Requirements Committee. Studying the trends so derived and allowing for the margin of error inherent in the estimation of food supply data, we may conclude that calorie supply per adult worker has probably decreased by up to 100 calories over the last 15 years. We conclude that the reduction in daily calorie supply is of a smaller order relative to the reduction in energy expenditure and that the difference can be placed at between 10 and 15 calories per annum.

It would be hazardous for one who is not a physiologist to attempt to translate these findings in terms of the trend of gain in bodyweight, since I have no knowledge whether all this excess supply goes in the formation of bodyweight, whether any part of it is excreted and how the relationship between excess calorie intake and gain in bodyweight changes at different levels of bodyweight. I would merely add what looks to me simple arithmetic, that if one were to assume all this excess in calorie intake were to be laid down as fat, an adult on average would be gaining in bodyweight to the tune of two thirds to 1 lb. per annum. Over the 14 year period from 1950-64 this would be equivalent to a gain in bodyweight of 10 to 15 lbs. per male adult.

4. TRENDS IN BODYWEIGHT

Direct evidence of gain in bodyweight is provided by data from surveys of physical measurement of the adult population. Such data for the USA from surveys carried out during the period 1941-63 are set out in Tables 6 and 7. Table 6 sets out the trends in average weight derived from the data collected by the National Centre for Health Statistics (1965, 1966) and American College Health Association Research Committee, while Table 7 shows the trend based on the data collected by the Metropolitan Life

Insurance Company and 26 other insurance companies in the USA. An examination of these tables shows that age for age there has been an increase in weight of the order of between 1-1½ lbs. per adult per annum. Table 6 shows a bigger gain than that recorded in Table 7. It is likely however that the data recorded in Table 6 for 1948-50 by the American College Health Association Research Committee relate to strata of society which have higher educational and social attainments and for this reason is not wholly comparable with the cross section of the population covered in 1960-62. In all probability, the difference is an overestimate of the actual gains even though the measurements have been adjusted to a comparable basis. The data presented in Table 7 have the merit that they are collected on a comparable basis from all insured persons numbering several thousand but the trend may reflect in part the differences in socio-economic strata likely to be different from those in the general population. Even with these drawbacks however the data leave little doubt that apart from adults becoming heavier and heavier, age for age, they put on significant and marked gains in weight as they become older. The gain is particularly large in males between the age groups 18/24 - 25/34. Thereafter the gains steadily diminish. Women are relatively more successful in controlling their weight up to the age group 25-34, but thereafter they too record gains in bodyweight comparable to or even exceeding those recorded by men.

5. INCIDENCE OF OBESITY AND ITS TREND

There is no generally agreed definition of obesity. Some workers, notably Mayer and Seltzer, 1965, have suggested definition based on caliper determination of skin-fold thickness; others use the simple approach of excess weight over published standards. The former is probably of greater value in clinical work; the latter however appears to be the more generally accepted line of thinking on obesity. Confining our attention to the latter, available literature shows that a person is considered to be obese when his weight exceeds 20% of the average weight of all adults in the population. Data of the nationwide survey conducted by the National Health Centre of the USA during 1960/62 show that the average weight of all adult males is 168 lbs. and that of all adult females is 142 lbs. The limits for obesity on the current convention therefore are 168 + .20 x 168, or approximately 200 lbs. for males, and 142 + .20 x 142, or 170 lbs. for females.

Table 8 shows the mean and the standard deviation of the distribution of weights of adults as observed in the nationwide survey conducted in the USA during 1960-62. It also shows the proportion of adults exceeding the limit of 200 lbs. for males and 170 lbs. for females. It will be seen that 12% of the adult males have a weight exceeding 200 lbs. and 16% of adult females have a weight exceeding 170 lbs. In other words, by current criteria the incidence of obesity in the population in the USA is 12% among males and 16% among females. The Tables also show that the incidence of obesity increases with age up to 65. The increase in the incidence of obesity with age is relatively more rapid in the case of males than females.

Overweight and obesity are relative terms. To use the average bodyweight of all adults in determining the limits beyond which a person can be classified as obese seems to us to beg the question since the average weight itself is influenced by the proportion of obese persons in the population. What is needed in our view is a reference weight based on a concept similar to that used by the FAO Committee on Calorie Requirements in defining calorie needs. According to this Committee a 'reference' man is 25 years old, weighs 70 kg. lives in a mean annual temperature of 10°C. and lives a healthy active life of moderate activity spending about 8 hours in working activities which are neither heavy nor sedentary, 8 hours in non-occupational activities and 8 hours rest in bed. Observations show that he consumes around 3200 calories per day. The calorie requirements for adults in other age groups are determined in relation to the deviation of bodyweight and of the degree of physical activity from those assumed for the 'reference' man.

Clearly, much the same approach is indicated in defining obesity. Heavier as an adult of 18-24 of today may be than he was 10 or 20 years ago, he is our 'reference' point and it is only in relation to the morbidity and mortality of healthy adults in this group that we can judge the significance of overweight and obesity. Experience has shown that conditions governing mortality and morbidity in life remain optimal when the bodyweight remains at the level it was during the age group 18-24 after a normal development characteristic of healthy active children. Adopting then our 'reference' man as a healthy active adult of the youngest adult age group of 18-24 experiencing the least risk of morbidity and mortality, we may define obesity as falling outside the normal range of weight of adults of the reference type.

But not all adults of the age group 18-24 can be regarded as healthy active adults subject to the same low risk of mortality and morbidity. Experience shows that the rates of mortality and morbidity increase as weight increases even in the age group 18-24. Carried to its logical conclusion this means that there is an optimal figure for weight for the youngest adult associated with least mortality, which when exceeded, makes a man increasingly overweight and susceptible to greater morbidity and mortality. But it is not practicable to define an optimal weight in terms of a single point in the scale of weights. Where, as in defining calorie needs, there is "a continuous progression from health to disease with increase in bodyweight" the only way of defining overweight and obesity is relative to the distribution of weight of healthy active adults of the youngest group experiencing the least mortality, and this is what we have ventured to suggest in the reasoning above. The reasoning is closely akin to that which has led the Metropolitan Life Insurance Company to de-

fine what they call the best or desirable weights associated with the least mortality and to give a range of desirable weights for different heights (Metro. Life Ins. Co., 1960). A study of these desirable weights shows the mean desirable weight is lower than the average weight of the youngest age group, being approx. 145 lbs. for males and 123 lbs. for females with the range extending from 112-204 lbs. for the former and 92-173 for the latter. Assuming normal distribution this would imply that the standard deviation of the weight of the 'reference' male adult is roughly of the order of 13-14 lbs. and that of the 'reference' female is of a like order. In other words, the probability that a healthy active adult of the reference group will exceed the mean desirable weight + three times standard deviation of the weight of the reference adult will be less than .01. If he should exceed this limit we can consider him to be obese and subject to a higher risk of mortality than the 'reference' adult.

We would have no hesitation in accepting the mean desirable weights as given by the Metropolitan Life Insurance Company as defining the mean weight of adults of the 'reference' type but adult males of 18-24 age group in 1960-62 were heavier by about 4-5 lbs. on the average than at the time when the Metropolitan Life Insurance Company prepared their tables. We shall be on the safe side if we say that our 'reference' man has a weight of around 150 lbs. with a standard deviation of 13-14. Likewise, our 'reference' woman will have a weight of around 125 lbs. with a standard deviation of around 13-14. Adopting this as our frame of reference then we may say that for the USA a limit of 150 + 3 s.d. or 190 lbs. can be considered as the limit to classify obese men and that of 165 lbs. to classify obese women.

In proposing these limits to define obesity we must utter a word of caution. The limits will change with the time consequent on the change of body size and the changing balance between energy expenditure and food intake. They are no more static than are the calorie requirements which also depend on the type of life people like to lead and their bodyweight.

Using the above limits we have calculated the incidence of obesity for the different age groups from the data collected by the NHS. These are shown in Table 8. As will be seen, the proportion of obese persons among males is slightly higher than we had estimated earlier using the conventional definition and amounts to some 21% and the proportion of obese persons among females is also 21%. The attached chart shows the method of estimating the incidence of obesity as also its extent.

We have projected the incidence of obesity for the year 1980 on the assumption of continued trend of excess intake of food relative to energy expenditure and the continued trend of increase in height and weight resulting partly from improved nutrition and partly from a tendency to marry outside one community. We find, using the normal form of distribution for bodyweight and coefficient of variation observed in 1960 in the N.H. Survey, that the incidence of obese people among the population is likely to increase by about one sixth by 1980. These calculations leave little doubt that the problem of obesity in the USA is likely to assume increasing significance unless food consumption further declines or physical activity during leisure and recreation is increased to compensate for the decrease in energy expenditure during working hours.

It is tempting to assess the impact of the trend in the incidence of obesity on the demographic picture but this is a complex task. Besides, the relevant data are not available. By way of example however we have calculated the potential gain in longevity to be had from preventing overweight and we find that the gain may amount to as much as two to three years in an expectation of 27 years for a man 45 years old (vide Table 9). Even in 1980, when life expectation will have increased at all ages on current trends of mortality as projected by the UN the potential gain in longevity to be had from preventing overweight remains much the same. The effect of controlling overweight on the life expectation of the population as a whole is necessarily smaller. Thus the potential gain in the expectation of life if overweight were controlled works out to a little over half a year (vide Table 10). Should the incidence of obesity increase by one sixth, as seems likely on current trends, the potential gain in life expectation will correspondingly increase, as can be readily seen from the Table. Even more significant than the potential gain in longevity is the reduction in the incidence of morbidity and of restricted activity through the development of what are termed by Linder (1966) "positive elements of health" in the form of a very considerable increase in the number of days of healthy living but we do not have data to illustrate these gains.

6. ACKNOWLEDGMENTS

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* Calorie requirement of the nutrition unit is that of the reference man being 3500 at retail level in 1955 and 3200 at retail level in 1965.

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Table 1

CALORIE SUPPLY COMPARED WITH CALORIE REQUIREMENTS

(per caput per day at retail level)

	Calorie Supply		Calorie Requirement	Supply as % requirement
1954-56	3160[1]	3200[2]	2600[3]	121
1964-66	3140[1]	3210[2]	2400[4]	133

Source: 1/ Food Balance Sheet for USA

2/ Household Food Consumption Survey, USA, 1955, 1965

3/ Based on recommended Dietary Allowances, 1958, Food and Nutrition Board, USA

4/ Based on recommended Dietary Allowances, 1964, Food and Nutrition Board, USA

Table 2

CALORIE SUPPLY BY INCOME LEVEL IN USA, 1955, 1965

(per caput per day at retail level)

Household disposable income ($/year)	1955	1965
Under 3000	3210	3120
3000 - 4999	3160	3180
5000 - 7999	3210	3230
8000 - 9999	3200	3280
10000 and over	3220	3300
TOTAL	3200	3210

Source: US Department of Agriculture (1957; 1967) Household Food Consumption Surveys 1955 and 1965

Table 3

DISTRIBUTION OF HOUSEHOLDS BY CALORIE SUPPLIES PER NUTRITION UNIT PER DAY - USA

(at retail level)

Calories per nutrition unit per day	Percentage frequency 1955	1965
Under 3000	12	14
3000 - 4000	28	26
4000 - 5000	28	27
5000 - 6000	16	17
6000 and over	16	16
Average calorie supply per nutrition unit per day	4390	4320
Average calorie requirement per nutrition unit per day	3500 1/	3200 2/
% households with calorie supply per nutrition unit exceeding 4400 (i.e. 3500 + 3 s.d.)	49	
% households with calorie supply per nutrition unit exceeding 4100 (i.e. 3200 + s.d.)		57

Source: 1/ Recommended Dietary Allowances for USA, Food and Nutrition Board, 1958
2/ Recommended Dietary Allowances for USA, Food and Nutrition Board, 1964

Table 4

PERCENT DISTRIBUTION OF ECONOMICALLY ACTIVE POPULATION BY MAJOR OCCUPATIONAL GROUPS - USA

Occupational Group	1940	1950	1960	1964
White collar workers	32.8	37.5	43.0	44.2
Blue collar workers	36.4	39.2	36.3	36.3
Service workers	12.5	10.9	12.6	13.2
Farm workers	18.3	12.4	8.1	6.3
Average calorie expenditure per minute of work	3.03	3.02	2.63	2.53
Index of trend in average calorie expenditure	100	100	87	84

Source: Statistical Abstract for USA, 1951 and 1965

Table 5

TRENDS IN DAILY PER CAPUT FOOD SUPPLY IN THE USA

	Calories from				
	Animal proteins	Vegetable proteins	Fats	Carbohydrates	Total Calories
Prewar	220	130	1130	1780	3260
1948-50	260	110	1220	1580	3170
54-56	275	105	1260	1520	3160
57-59	280	100	1250	1480	3110
60-62	275	100	1265	1460	3100
63-65	280	100	1270	1490	3140

Source: Derived from Production Yearbook (1966), FAO, Rome

Table 6

AVERAGE WEIGHT BY AGE FOR ADULT MALES AND FEMALES

Age Group (years)	Actual Average Weight * (lbs) 1948-50		1960-62+	
	males	females	males	females
18 - 24	151	122	160	129
25 - 34	156	125	171	136
35 - 54	162	136	172	145

*Adjusted to partial clothing without shoes

+U.S. National Health Survey 1960-62

Table 7

TRENDS IN AVERAGE WEIGHT, 1941-63*

Age Group males	1941 Metropolitan	1935-53 26 Companies	1963 Metropolitan
	. . . . . weight (lbs)		
18 - 24	149	147	157
25 - 34	155	157	164
35 - 44	159	161	167
45 - 54	160	162	166
55 - 64	159	162	163

*Adjusted to partial clothing without shoes

Source: Statistical Bulletin, Metro.Life.Ins.Co.,Vol.47, 1966

Table 8

INCIDENCE OF OBESE AMONG ADULTS IN USA

Age Group (years)	Mean weight $\bar{w}$ (lbs)		Standard deviation (lbs)		Proportion of males exceeding*		Proportion of females exceeding	
	males	females	males	females	$\bar{w}$ + .20$\bar{w}$	$\hat{\bar{w}}$ + 3 s.d.	$\bar{w}$ + .20$\bar{w}$	$\hat{\bar{w}}$ + 3 s.d. of desirable weight
18 - 24	160	129	26	30	.06	.12	.08	.11
25 - 34	171	136	28	34	.15	.24	.16	.19
35 - 44	172	144	26	30	.15	.24	.19	.24
45 - 54	172	146	27	30	.15	.25	.21	.26
55 - 64	166	153	27	30	.11	.19	.28	.34
65 - 74	160	147	27	26	.07	.13	.18	.24
75 - 79	150	139	26	28	.03	.06	.13	.17
TOTAL	168	142	27	29	.12	.21	.16	.21

*These are derived on the assumption that the observed distribution of weights are normally distributed with mean and standard deviation given in columns 2 and 3. The proportion corresponds closely with the actual observed proportion as can be verified from the Tables given in the Report No.8 of Series 11 published by the National Center for Health Statistics, U.S.A.

Table 9

GAINS IN LONGEVITY FOR THE OVERWEIGHTS IF OVERWEIGHT WERE CONTROLLED

Expectation of Life in U.S.A. Males - 1959 and 1980

(1)	(2)	(3)	(4)	(5)	(6)	(7)
	1959			1980		
Age	All males excluding overweights 10% and more	Overweights only 10% and more	Years of life gained	All males excluding overweights 10% and more	Overweights only 10% and more	Years of life gained
0	67.0	64.3	2.7	71.8	69.2	2.6
25	45.5	42.8	2.7	48.7	46.1	2.6
45	27.4	24.9	2.5	29.7	27.3	2.4
65	13.0	11.3	1.7	14.2	12.4	1.6
% of population	79	21		75	25	

Source: Derived from data on mortality rates for USA and proportion of an excess mortality among overweights as reported in the Build and Blood Pressure Study, Society of Actuaries (1960).

Table 10

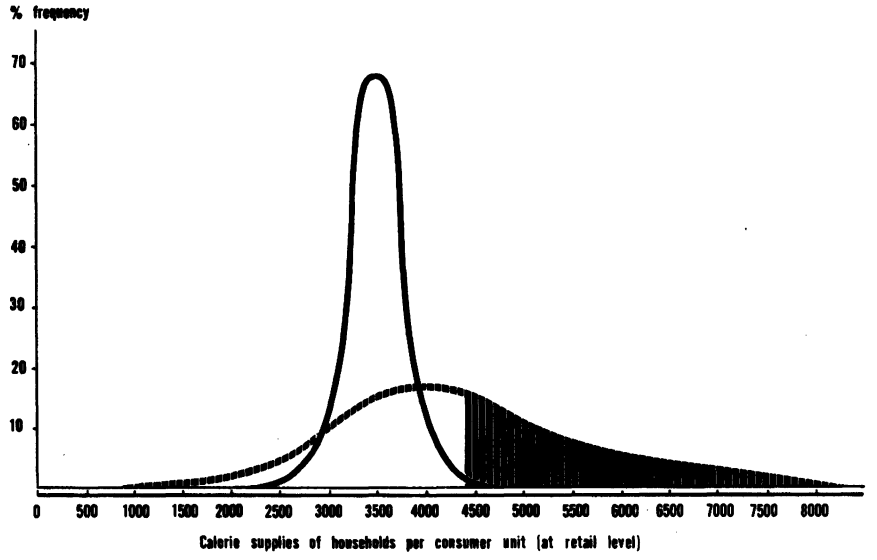
GAINS IN LONGEVITY FOR THE WHOLE POPULATION IF OVERWEIGHT WERE CONTROLLED

Expectation of Life in U.S.A. Males - 1959 and 1980

		1959			1980	
Age	All males	All males excluding overweights 10% and more	Years of life gained	All males	All males excluding overweights 10% and more	Years of life gained
0	66.4	67.0	0.6	71.1	71.8	0.7
25	44.9	45.5	0.6	48.0	48.7	0.7
45	26.8	27.4	0.6	29.1	29.7	0.6
65	12.6	13.0	0.4	13.7	14.2	0.5
% of population		79			79	

Source: Derived from data on mortality rates for USA and proportion of an excess mortality among overweights as reported in the Build and Blood Pressure Study, Society of Actuaries (1960).

CHART 2e - OVERNUTRITION IN THE U.S.A. (1955)



Incidence of obese among adult men - USA - 1960