

Regular Review

Weight penalties

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Life insurance actuaries know that overweight people tend to die young and hence are not profitable to insure. The experience of 4.5 million insured lives over 1935-54 indicated¹ that there is a "desirable range" of weight for men and women which is associated with greatest longevity. In response to popular demand this range of weight-for-height was further divided to cater for large, medium, and small frame size, and the resulting table of "ideal weights" is often shown on public weighing machines and used by commercial slimming clubs to set targets for their members. There is no scientific basis for the subdivision by frame size, nor is there any recognised procedure by which the frame size of an individual can be classified, but the original data for the limits of the "desirable range" are still valid. It happens that the boundaries of these ranges may conveniently be expressed by the ratio W/H^2 , where W is the individual's weight in kilogrammes and H is height in metres. For men the range of W/H^2 is from 20 to 25 and for women from 19 to 24. This physique, which is associated with longevity, is similar to that found in very good athletes,² though Olympic champion sprinters (W/H^2 about 23) are somewhat stockier than marathon runners (W/H^2 about 20). But about one-third of the adults in Britain and the United States are above the maximum of the desirable range of weight-for-height, and the proportion of the population which is overweight seems to be increasing with successive surveys.³

The Build and Blood Pressure Study¹ was useful to life insurance companies but was unsatisfactory to clinicians and epidemiologists. People taking out life insurance are a selected population. Weight at insurance seemed an unlikely determinant of the nature of the disease causing death 30 or more years later, and prospective trials were set up to discover the cause of excess mortality in overweight people. Among employees of the Chicago People's Gas Company⁴ mild obesity was found to be associated with a lower mortality than "ideal" weight, and a large survey by Keys *et al*⁵ found that, when age, blood pressure, serum cholesterol concentration, and smoking were taken into account, no measure of relative weight or obesity made a significant contribution to predicting the risk of future heart disease. By the early 1970s epidemiologists were claiming that the risk of obesity in itself had been exaggerated and that the life insurance data reflected risks of other factors which were themselves often associated with obesity.⁶

Some recent publications have clarified these apparent contradictions. A 26-year prospective survey⁷ of 3983 men in Manitoba showed that there was a positive correlation between initial W/H^2 and the incidence of ischaemic heart disease in men under the age of 40—but that this association became evident only after 16 years of follow-up. When the data from the Chicago People's Gas Company (1264 persons) were

pooled with four other major series⁸ to give a total of 12 516 men and women it became clear that high relative weight is associated with increased risk of a first major coronary event *only* for men under 50 years old. Between 50 and 55 overweight carries no extra risk, and over 55 there is a slight (insignificant) reduction in risk. Similarly the likelihood that overweight people will also be hypertensive depends on age,⁹ according to a survey of one million Americans sent a questionnaire to determine the association between overweight (self-reported) and hypertension (defined as diastolic pressure over 95 mm Hg, or current use of antihypertensive drugs). One may have reservations about data collected in this way, but there is no reason to doubt the conclusion that the association between overweight and hypertension is much stronger in persons 20-39 years old than in those 40-64 years old.

Strong further support for the conclusions of the 1959 Build and Blood Pressure Study¹ has now come from a large survey¹⁰ started in 1959 by the American Cancer Society (ACS). Some 68 000 volunteer workers for the society enrolled more than one million men and women: family groups were chosen with at least one member over the age of 45 and all members of the household over 30 were asked to answer the questionnaire. Each year the volunteer reported if the enrolled individuals were alive or dead and if dead a copy of the death certificate was obtained. At the end of 12 years 92.8% of the study population (alive or dead) were successfully traced. The data were analysed to determine the variations in mortality by weight among the 336 442 men and 419 060 women who completed the study, and who were not ill on entry to the survey, did not have a history of cancer, heart disease, or stroke, and did not lose 10 or more lb (4.5 kg) in the preceding year.¹⁰

Weight categories were assigned relative to the average of the sex-age-height group concerned. This average weight for the men was close to the upper boundary of the "desirable range" of weight from life insurance statistics: the W/H^2 of a man in the "90-109% of average weight" group of the ACS survey would be 24-28, and for women this group would have W/H^2 about 19-23. About 60% of the men under 75 and about 50% of the women under 75 fell into this "average weight" group. The most overweight group comprised those more than 140% of average weight: from 0.4 to 0.8% of the men and 1.3 to 3.0% of the women were in this category.

The lowest mortalities were found in the groups from 80% to 109% of average weight. If average weight mortality is taken to be 100 the mortality in those less than 80% of average weight was increased at 125 and 119 for men and women respectively. With overweight, mortality steadily increased: the value for men at 110-119% average weight was 115; at 120-129% 127; at 130-139% 146; and over 140% 187. For women

the corresponding values were 117, 127, 146, and 189. These results are strikingly similar to those in the results of the Build and Blood Pressure Study, though the former were obtained by self-reporting and the latter from medical insurance examinations. Indeed, if the American Cancer Society data were used to derive a range of "desirable" weights for height they would again suggest that W/H^2 values of 20-25 are best.

When mortality ratios in overweight persons are analysed by disease groups (again taking the mortality for that disease in average weight category as 100) the rate in the most overweight groups of men was 519 for diabetes, 399 for digestive diseases, 227 for cerebrovascular disease, 195 for coronary heart disease, and 133 for cancer (all sites); for women the corresponding figures were 790, 299, 152, 207, and 155. In each case the less severely overweight groups showed roughly pro rata increases in mortality ratios. The major factor in the higher relative mortality among overweight people was increased mortality from coronary disease. Excess mortality with overweight was greater in younger than in older people.

Smoking and other factors—In the American Cancer Society study¹⁰ men and women smoking 20 or more cigarettes a day recorded by far the highest mortality from all causes in all weight categories, while non-smokers showed low mortality rates from all causes combined in all weight categories. Among 3686 longshoremen followed for 22 years¹¹ smokers had an increased mortality, especially from heart attack and respiratory disease, but those who were less active also had an increased risk of heart attack. Similar results came from a study of male civil servants¹²: smoking and inactivity contributed independently to coronary heart disease mortality. The link between overweight and ischaemic heart disease might possibly be that obesity causes inactivity, which causes heart disease,¹³ but there are few convincing studies on the relationship of obesity to inactivity. A study in Puerto Rico¹⁴ found an association between inactivity and coronary heart disease in urban men, but overweight (which was associated with higher blood lipid values and less physical activity) was not significantly related to coronary heart disease in this short prospective survey lasting two and a half years. In a cross-sectional survey in Finland¹⁵ no association was found between overweight and ischaemic heart disease.

Association or cause?—Without any doubt, then, overweight people of both sexes, especially young overweight people, tend to die sooner than their lean contemporaries,¹⁶ and this effect is not confined to those who take out life insurance.¹⁰ The effect of smoking on mortality seems to be separate from that of overweight^{10,12}; and the effect of overweight on mortality and morbidity is delayed, so it is not seen in cross-sectional or short-term surveys^{5,14,15} but emerges more clearly after six years¹⁰ or more.^{7,16}

Many important questions have to be answered. Is the excess weight fat or some other component? Is the association between overweight and mortality mediated through some link which might be easier to attack than obesity itself: is that link inactivity or some component of blood lipids? Alternatively, are overweight and early death both manifestations of a genetic predisposition about which we can do nothing?

To prove that overweight is the cause of the excess mortality with which it is associated obesity would have to be induced for many years in a large group of previously lean normal volunteers, and this is ethically impossible. The alternative is to observe the effects of reversing obesity in some patients,

while leaving a similar control group obese. This is also difficult. The results of uncontrolled trials are encouraging: life insurance data show that clients refused insurance at normal rates on account of obesity attain normal risk when they attain normal weight,¹⁷ but these are highly selected individuals.

I believe that we have enough information to make intelligent guesses at the answers to the questions posed above, though formal proof of their accuracy is probably unattainable. Almost certainly people with W/H^2 over 25 have too much fat—unless they are professional weight-lifters or boxers. The life insurance experience¹⁷ suggests that the association between overweight and excess mortality is reversible if weight is lost and is preventable by preventing obesity. The nature of the link between overweight and excess mortality seems likely to have several components: inactivity and hyperlipidaemia (which are themselves associated) may be implicated, as may other factors such as the difficulty in providing medical care for obese people¹⁸ and their increased anaesthetic and surgical risks. Discovery of an important and easily severed link would be a major advance, but meanwhile the most effective option is to tackle obesity itself, especially in young people. Perhaps, in the light of recent evidence, more doctors will be convinced that weight penalties are severe and that effort is well spent in avoiding them. If so, this conviction may get through to our young overweight patients, who will then be encouraged to help themselves.

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¹ *Build and Blood Pressure Study*. Chicago, Society of Actuaries, 1959.

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⁵ Keys, A, *et al*, Coronary heart disease: overweight and obesity as risk factors, *Annals of Internal Medicine*, 1972, **77**, 15.

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⁸ Cook, L, Relationship of blood pressure, serum cholesterol, smoking habit, relative weight and ECG abnormalities to incidence of major coronary events: final report of the pooling project. The Pooling Project Research Group, *Journal of Chronic Diseases*, 1978, **31**, 201.

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¹¹ Paffenbarger, R S jun, *et al*, Energy expenditure, cigarette smoking, and blood pressure level as related to death from specific diseases, *American Journal of Epidemiology*, 1978, **108**, 12.

¹² Chave, S P W, *et al*, Vigorous exercise in leisure time and the death rate: a study of male civil servants, *Journal of Epidemiology and Community Health*, 1978, **32**, 239.

¹³ Stern, S, Obesity and ischaemic heart disease, *American Journal of Cardiology*, 1978, **41**, 622.

¹⁴ Costas, R jun, *et al*, Relation of lipids, weight and physical activity to incidence of coronary heart disease: the Puerto Rico heart study, *American Journal of Cardiology*, 1978, **42**, 653.

¹⁵ Juustila, H, Overweight and obesity as risk factors of IHD, *Acta Medica Scandinavica*, 1977, **613**, suppl, p 17.

¹⁶ Blair, B F, and Haines, L W, Mortality experience according to build at the higher durations, *Society of Actuaries*, 1966, **18**, 35.

¹⁷ Dublin, L I, Relation of obesity to longevity, *New England Journal of Medicine*, 1953, **248**, 971.

¹⁸ Garrow, J S, How dangerous is obesity? *British Medical Journal*, 1977, **1**, 1345.