FIT AND FAT?

Can you be fit and fat? What is the impact of exercise and weight control on the morbidity associated with obesity?

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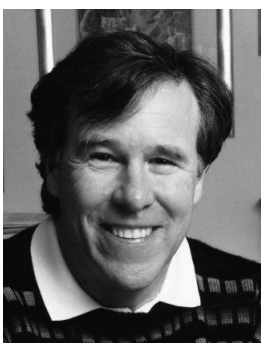

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Tim Noakes's research focuses on the development of a novel neurobiological model of integrated human function during exercise to optimise human exercise performance, as well as on the treatment and prevention of sports injuries and chronic diseases. He has more than 350 scientific publications and is the author of Lore of Running *– the 'Bible' of running. He is co-author of 4 other books on sport. Tim has received many prestigious awards, e.g. the International Cannes Grand Prix Award for his study of water intoxication in athletes.*

SCOPE OF THE PROBLEM

South Africa has not escaped the current global trend towards obesity. Results from the National Demographic and Health Survey, published in 2002,[1] found that over 57% of adult South African women were overweight or obese, double that of adult South African men, whereas 29% of the population may be classified as either overweight or obese. Besides nutritional factors, physical inactivity is one of the major global contributors implicated in the recent surge in the prevalence of obesity. For example, currently, over 60% of the American public do not meet the minimum recommended level of exercise of 30 minutes a day for most days of the week, while in South Africa over 46% of the population are equally physically inactive. The interaction between physical inactivity and other risk factors for chronic disease, including obesity, on the burden of illness from chronic disease, is currently under the spotlight. The question often asked is: can one be fit and fat?

EPIDEMIOLOGICAL EVIDENCE

Perhaps the most convincing evidence fuelling this debate comes from a series of cohort studies from the Aerobics Centre Longitudinal study.[2-4] These studies have investigated more than 25 000 men over a 26-year period from 1979 to 1995, all of whom underwent fitness testing at the Cooper Clinic in Dallas. The participants were monitored for measures of cardiorespiratory fitness, body weight and various components of the metabolic syndrome, including high blood pressure, central obesity, dyslipidaemia and type II diabetes. Data reported by Katzmarzyk *et al.*[3] examined the link between cardiorespiratory fitness and all-cause mortality and mortality associated with cardiovascular disease in more than 20 000 men. Cardiorespiratory fitness was assessed using a maximal, graded treadmill exercise test, and participants generally represented a group of well-educated (~75% college graduates), white, non-Hispanic individuals. Initially, it was found that being overweight (odds ratio = 4.7) and obesity (odds ratio = 30.6) significantly increased the probability of developing diseases associated with the metabolic syndrome. In addition, independent of metabolic syndrome status, mortality rates were significantly increased for the obese compared with those who were either overweight or of normal weight, whereas the risk for all-cause mortality was highest in obese men with the metabolic syndrome. However, when cardiorespiratory fitness was included in the analysis, the risks associated with obesity and the metabolic syndrome disappeared, i.e. when cardiovascular disease mortality was adjusted for differences in cardiorespiratory fitness, all the relative risks were attenuated and the risk was not different in the different body weight categories. This study provides strong evi-

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dence to support the concept that low cardiorespiratory fitness contributes more to mortality risk than does fatness, whereas fitness reduces the impact of fatness on mortality.

A study by Stevens *et al.*[5] provided further evidence for this hypothesis – this time in a diverse group of men and women. In a study similar to that of Katzmarzyk *et al.*[3] 7 500 participants were screened for all-risk mortality and cardiovascular disease in relation to body fatness and cardiorespiratory fitness. The cardiorespiratory testing included a maximal exercise test performed on a treadmill, while physical activity status was assessed using a questionnaire, categorising individuals as either: (*i*) very active; (*ii*) moderately active; or (*iii*) inactive. In this cohort, there was a poor correlation between body mass index (BMI) and fitness, although it was evident that as fitness levels decreased body weight increased (Figs 1 and 2).

Interestingly, 7% of obese women and 10% of obese men were classified in the category of being most fit. Furthermore, BMIs of these individuals were not necessarily close to the borderline cut-off BMI between overweight (BMI = 29) and obese (BMI = 30). All-cause mortality rates were similar across quintiles of fatness, except for the highest quintile, in which mortality was increased for both men and women. There was a systematic increase in mortality as BMI increased, whereas both all-cause mortality and cardiovascular mortality decreased with increasing fitness in both men and women. Using a hazards ratio, the cohort was analysed according to the categories of 'fit and not fat', 'fit and fat', 'unfit and not fat' and 'unfit and fat'. The category of 'fit and not fat' was used as a reference point. For women, the risks of all-cause and cardiovascular mortality were significantly increased above the reference group in all other groups, with the exception of cardiovascular mortality which was not increased in the 'fit and fat' group. Similarly for the men the hazards ratios were increased above the reference group for each category.

The authors concluded that the effect of fitness was statistically independent of the level of fatness. The reverse

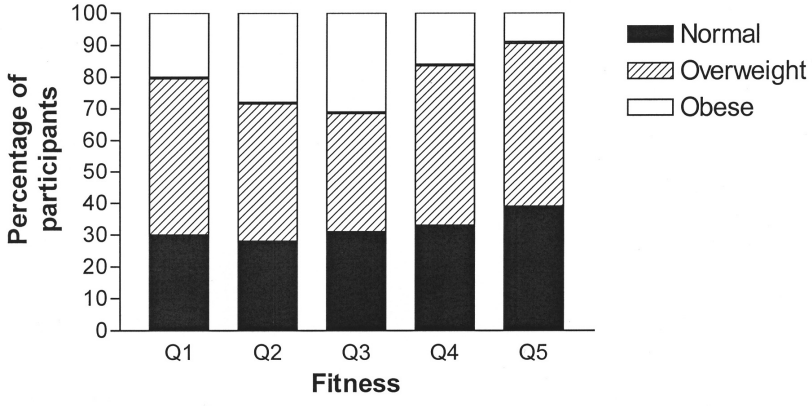

Fig. 1. Percentage of male participants classified as having normal weight (BMI = 18.5 - 24.9), being overweight (BMI = 25 - 29.9), and being obese (BMI ≥ 30) within quintiles (Q) of fitness levels (Lipid Research Clinics Study, 1972 - 1976). Note that increasing levels of fitness are associated with a reduced incidence of overweight and obesity. (Adapted from Stevens et al.[5]*)*

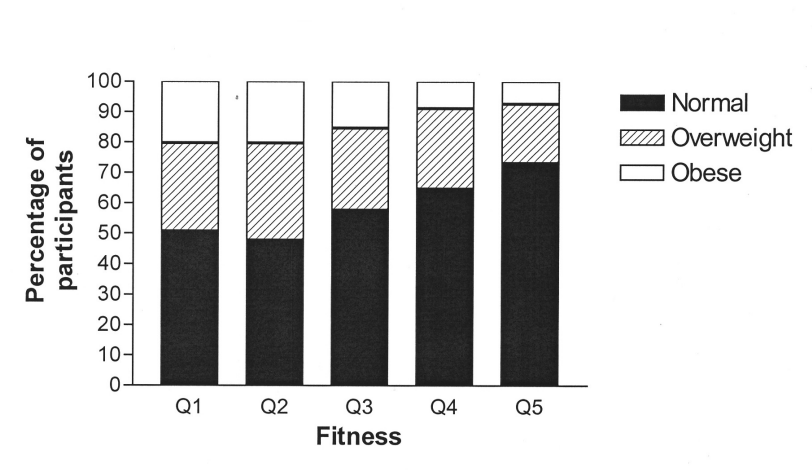

Fig. 2. Percentage of female participants classified as having normal weight (BMI = 18.5 - 24.9), being overweight (BMI = 25 - 29.9), and being obese (BMI ≥ 30) within quintiles (Q) of fitness levels (Lipid Research Clinics Study, 1972 - 1976). Note that increasing levels of fitness are associated with a reduced incidence of overweight and obesity. (Adapted from Stevens et al.[5]*)*

The bulk of epidemiological evidence suggests that accumulating at least 30 minutes of moderate intensity exercise on a daily basis is sufficient for producing a substantial reduction in risk for mortality and morbidity for chronic disease.

was not clear, i.e. the effect of fatness independent of fitness was less obvious. BMI quintiles were associated with mortality after controlling for fitness, but these effects were smaller than those seen with fitness. Furthermore, the hazards ratio associated with fitness and fatness was not greatly reduced for both men and women if both variables were included in the model. This study concluded that both high levels of fatness and low levels of fitness contributed to increased mortality from all-cause and cardiovascular disease. The effect of fitness appears to be more consistent than that of fatness, whereas being fit did not necessarily exclude the presence of fatness.

PHYSICAL ACTIVITY IMPROVES 'METABOLIC FITNESS' AT ANY GIVEN BMI

A study by Wong *et al.*[4] provides further convincing evidence for the value of cardiorespiratory fitness in ameliorating disease even in overweight people. A sample of men from the Aerobics Centre Longitudinal cohort was monitored for 7 years. Initially, all 397 participants were non-smokers and free from diabetes, heart attack, stroke and cancer and ranged in age from 30 to 76 years. A computed tomography (CT) scan of the abdominal region for the measurement of abdominal adipose tissue distribution was performed as part of complete medical screening, which included both physical and sociodemographic investigations. Finally, all participants performed a cardiorespiratory fitness test to exhaustion. Initially, subjects were assigned to five age-specific cardiorespiratory fitness quintiles, based on their age and treadmill test result and according to specific cut-off points generated from the larger Aerobics Centre Longitudinal study. However, because of the small sample size, investigators chose to separate participants into either high or low cardiorespiratory fitness groups, using the upper two and lower two quintile groups.

There was no statistical difference between fitness groups with regard to age or adiposity. However, superficial subcutaneous adipose tissue content was significantly lower in the high cardiorespiratory fitness group. Furthermore, this group had lower waist circumferences for any given BMI and age than the lower cardiorespiratory fitness group. Further examination of CT data revealed that men in the high cardiorespiratory fitness group had significantly less visceral and abdominal subcutaneous adipose tissue and lower deep and superficial subcutaneous adipose tissue than men in the lower cardiorespiratory fitness group. Abdominal adipose tissue has been implicated as a risk factor for the metabolic syndrome.[6] Therefore the finding that for any given BMI men with higher cardiorespiratory fitness have significantly lower levels of abdominal adipose tissue is of particular importance. This finding provides evidence that cardiorespiratory fitness attenuates the health risks and consequences of obesity as a result of reducing abdominal adipose tissue.

On a more practical level the study provides evidence for the value of waist circumference measurement in place of abdominal CT, which is costly and time consuming. In the current study, men with higher cardiorespiratory fitness had smaller waist circumferences than those with low cardiorespiratory fitness, independent of BMI. In addition, the men with the higher cardiorespiratory fitness had overall lower levels of total abdominal, subcutaneous and visceral adipose tissue. This therefore supports the use of the waist circumference measurement for estimating mortality and morbidity risk.

Additional evidence for the role of physical fitness and body fatness in the development of the metabolic syndrome was recently provided by Boule *et al.*[7] In that study, 356 men and women were investigated for the associations between physical fitness and the metabolic syndrome, independent of total and abdominal obesity. All participants performed a submaximal cardiorespiratory fitness test on a stationary cycle ergometer, while body composition was determined by hydrostatic weighing and abdominal and visceral subcutaneous fat by CT scan. Based on the cardiorespiratory fitness test, participants were categorised into fitness tertiles. The study found that the prevalence of the metabolic syndrome decreased with increasing fitness and was different for men and women. For the men, the least fit individuals (lowest tertile) were six times more likely to present with the metabolic syndrome than those in the highest tertile, whereas women in the lowest tertile were four times more likely to present with the metabolic syndrome than those in the highest fitness tertile.

IS FITNESS ENOUGH?

However, not all studies agree that fitness is a better predictor of both all-cause and cardiovascular mortality than fatness. A recent study by Christou *et al.*[8] found that, in healthy men, measurements of body fatness (BMI, waist circumference and percentage body fat) were better predictors of cardiovascular disease mortality than aerobic fitness. In this study, 135 healthy men were screened for cardiovascular disease risk factors, including haemodynamic risk factors (e.g. blood pressure, arterial stiffness and carotid and femoral artery intima-media thickness), haemostatic factors (e.g. plasma tissue plasminogen factor and plasminogen activator inhibitor type-1) and metabolic risk factors (e.g. plasma lipids, lipoproteins, plasma insulin and glucose concentrations). In addition

body composition (using dual X-ray absorptiometry), BMI, waist circumference and maximal exercise capacity were assessed.

After separating out the effect of fitness, BMI, percentage body fat and waist circumference were significantly correlated ($p < 0.05$) with plasma lipids, lipoproteins, plasma insulin and glucose concentrations, while aerobic fitness correlated with only selected triglycerides and fasting insulin concentrations. BMI and waist circumference were further correlated with blood pressure, arterial stiffness and carotid and femoral artery intima-media thickness, while fitness was not independently associated with any of the plasma haemodynamic factors. In the study it was found that, overall, fatness was more strongly and consistently associated with cardiovascular disease than fitness.

EXERCISE IN THE TREATMENT OF OBESITY: UNDERLYING MECHANISMS

Although the role of fitness versus fatness is the subject of some debate, there is ample evidence that physical activity is an important component in the prevention and management of overweight and obesity. The effects of physical activity on the attenuation of obesity are, in part, attributed to increased levels of energy expenditure, a reduction in body fat, increased fat-free mass, and altered adipose tissue distribution, as mentioned above. Moreover, there is evidence that physical activity and increased cardiorespiratory fitness may increase the overall contribution of fat oxidation to substrate metabolism.[9] Furthermore, regular exercise is associated with increased adherence to dietary intervention for weight loss and weight control, improved self-efficacy and better long-term weight loss maintenance. As such, physical activity has the potential to be a powerful 'agent of change' in the prevention and management of overweight and obesity, irrespective of the fitness versus fatness debate.

PRACTICAL CONSIDERATIONS FOR PUBLIC HEALTH RECOMMENDATIONS AND EXERCISE PRESCRIPTION

For health professionals it is important to 'translate' the message of physical activity into a measurable 'dose' for purposes of exercise prescription and self-monitoring. The bulk of epidemiological evidence suggests that accumulating at least 30 minutes of moderate-intensity exercise on a daily basis is sufficient for producing a substantial reduction in risk for mortality and morbidity for chronic disease. This forms the basis of the current American College of Sports Medicine recommendation for regular physical activity. However, in 2002 the United States Institute of Medicine recognised that this dose of physical activity may not be sufficient to prevent 'unhealthful weight gain' in many adults.[10] For these persons, additional physical activity may be warranted, or appropriately instigated dietary intervention may be needed. The discrepancy between these two public health recommendations may provide the underlying evidence that fitness and fatness impart different protection to chronic disease of lifestyle. The difficulty in interpretation is that physical activity may confound the relationship between obesity and associated morbidity.

CONCLUSIONS

There is strong evidence that the attainment of fitness and lower levels of body fatness are good for health and longevity. Furthermore, studies conclusively provide evidence that more fit individuals appear to have less subcutaneous body fat than their unfit counterparts, even at similar BMIs. Subcutaneous body fat has been implicated in the incidence of the metabolic syndrome. Indeed, a recent study, by Goodpaster *et al.*[6] concluded that, in addition to obesity, the distribution of body fat adipose tissue is independently associated with the metabolic syndrome, particularly for men and women in the normal range of body weight.

Therefore, taken together, these studies clearly suggest that the 'take home message' for the general public should not only be focused on issues of body fatness alone, but also on the attainment of cardiorespiratory fitness. The American College of Sports Medicine and the United States Institute of Medicine[10] both recommend that individuals accumulate at least 210 - 430 minutes of cardiovascular activity during a normal working week in order to gain the optimum health benefits from physical activity. Finally, while physical activity is an important component of weight loss, more significantly it is the best predictor of long-term weight maintenance.

References available on request.

IN A NUTSHELL

Physical activity or cardiorespiratory fitness imparts a protective effect for chronic diseases of lifestyle, which is probably independent of fatness.

Physical fitness attenuates blood pressure, serum lipids, insulin resistance and other morbidity associated with the metabolic syndrome at any given BMI.

Physical activity contributes to weight management and the prevention and control of obesity directly through increased energy expenditure, increased fat-free mass, and increased fat oxidation. Indirectly, physical activity enhances compliance and self-efficacy to dietary and lifestyle change.

Current public health recommendations suggest that at least 30 minutes of moderate-intensity exercise daily may protect against most chronic diseases of lifestyle; however, this may be insufficient to prevent 'unhealthful' weight gain in many adults.