Obesity and physical activity: A review
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Background and Methods Obesity has become a problem of epidemic proportions in the U.S., with nearly two thirds of American adults being either overweight or obese. Current data suggest that this trend remains on the rise and threatens many of the gains that have been made in the prevention and treatment of heart disease. Exercise has long been considered an integral component of weight management, but available evidence suggests that exercise alone is a relatively inefficient means for losing weight. In contrast, regular exercise appears crucial in the prevention of weight gain and successful maintenance of weight loss, and in the fostering of cardiovascular health. This article reviews the available literature regarding the role of exercise in the prevention and treatment of obesity and evaluates the adequacy of current national guidelines. (Am Heart J 2006;151:598-603.)

Obesity is a problem of epidemic proportions in the United States. According to results from the most recent National Health and Nutrition Examination Survey (NHANES 1999-2000), 31% of adults in the United States are obese (body mass index [BMI] >30). Include the 34% who are overweight (BMI 25.0-29.9) and 65% of American adults carry excess weight—almost 20% more than just 20 years ago.1,2 The rapid and nearly indiscriminate spread of obesity through our country has been likened to that of a communicable disease.3

Approximately 300,000 deaths a year can be directly attributed to obesity.4 Research has implicated obesity in the development of a wide range of diseases including coronary artery disease, hypertension, hyperlipidemia, diabetes mellitus, depression, breast cancer, colon cancer, prostate cancer, endometrial cancer, gallbladder disease, sleep apnea, chronic back pain, and osteoarthritis.5-7 In 1998 the American Heart Association reclassified obesity as a major, modifiable risk factor8 and issued a call to action9 for more research into the prevention and treatment of obesity.10 As a result of this and other initiatives, a growing body of data now exists on the role of diet and exercise in the management of obesity.

Physical activity and the development of obesity
Although there are no randomized controlled trials evaluating physical inactivity as the cause of obesity in a large population, there are significant amounts of observational data to support a causative link. In a review of 8 prospective studies contained in a recent Roundtable Consensus Statement from the American College of Sports Medicine (ACSM), researchers reported a “moderately strong” relationship between low levels of physical activity and the risk of developing obesity.6 Researchers at the Cooper Clinic in Dallas analyzed data from >5300 men and women who underwent 3 examinations at their clinic between 1970 and 1994. The subjects had their weight, peak VO2, and other parameters measured at each visit during this period. For each 1-minute improvement in exercise time from the first examination to the second there was a 21% reduction in the odds of gaining 10 kg over the average 7.5-year study period.11 Recent data from a randomized controlled exercise trial done at Duke University showed that there was a dose-response relationship between the volume of weekly exercise performed and the amount of weight change in non-dieting, overweight subjects. A minimum dose of exercise equivalent to walking or jogging 6 to 7 mile/wk was found to be a sufficient volume to stave off the 2.5 lb gained by the nonexercising controls over a 6-month period.12

According to the Surgeon General’s Report on Physical Activity and Health, physical inactivity is also at epidemic levels with recent prevalence rates paralleling those for obesity. In the latest survey, >60% of adult Americans reported infrequent activity and 25% said they were totally sedentary.13 These numbers have been relatively stable over the past several decades; they only account for participation in sports, fitness, and leisure-
time activities and do not attempt to quantify time or energy expended in activities of daily living. Researchers have theorized that the biggest decrement in energy expenditure has come from technical advances that have engineered physical activity out of modern life.\textsuperscript{12,13} For example, Haskell\textsuperscript{13} estimated that substituting 2 minutes of e-mailing per hour for walking down the hall to a colleague’s office would result in a 5-kg weight gain over the period of a decade.

### Exercise in the treatment of obesity

#### Weight loss

Numerous studies suggest that exercise alone is a rather inefficient means of weight loss.\textsuperscript{14-16} It takes approximately 35 miles of running or walking to burn a pound of fat. An expert panel reviewed data from 12 randomized controlled trials that analyzed the effects of aerobic exercise without diet intervention on weight loss. Exercisers lost an average of 5 lb more than nonexercisers during a 9-month average period.\textsuperscript{14} However, most health care providers and obese individuals would find a 5-lb weight loss of limited significance. Two meta-analyses on the same subject found similar results.\textsuperscript{17,18} Unfortunately, these studies are limited because free-living participants often change their dietary intake despite explicit instructions to the contrary.

However, in a recent small randomized controlled trial involving 52 obese men, the 14 subjects assigned to exercise enough to burn 2940 kcal/d lost an average of 16 lb during the 12-week study period.\textsuperscript{19} Perhaps the best evidence that exercise alone can result in weight loss is contained in a study by Bouchard et al,\textsuperscript{20} in which 5 men were placed in a residential facility where they exercised for two 53-minute sessions, 6 days a week for 100 days whereas their dietary intake was strictly monitored and held constant. After 3 months, the men lost an average of 8 kg. Because the dramatic weight loss in this closely controlled study can only partially be explained by an increased quantity of exercise relative to other studies, this lends credence to the widely held belief that an increase in physical activity is often accompanied by a concomitant increase in food intake that goes undocumented in food logs and recall questionnaires. Underreporting of energy intake is a well-documented phenomenon in obese subjects.\textsuperscript{21}

#### Maintenance of weight loss

As opposed to its modest role in weight loss, exercise seems to play a more crucial part in the maintenance of weight loss. A recent meta-analysis of 6 randomized controlled trials comparing the effects of diet versus diet plus exercise on maintaining weight loss during ≥1 year of follow-up found that subjects in the diet-plus-exercise arms in all 6 studies fared better at maintaining weight loss over the ensuing year(s) than the subjects in the diet-only arm. However, the difference reached statistical significance in only 2 of the 6 studies.\textsuperscript{16} Similarly, a systematic review of 46 observational and randomized trials looking at the role of exercise in weight maintenance showed an inconsistent association between physical activity and weight maintenance. However, among the randomized trials included in the analysis, there was an overall trend toward better weight maintenance in the exercise groups as compared with the controls, with the level of activity proportional to the amount of weight kept off.\textsuperscript{22}

The bulk of the data supporting exercise’s key role in weight loss maintenance comes from observational studies and post hoc analyses of weight loss trials. The most convincing evidence comes out of the National Weight Control Registry. Founded in 1994, the Registry contains data on >3000 subjects who have kept ≥30 lb off for ≥1 year. Almost invariably, those successful at maintaining weight use 3 behavioral strategies: (1) eating a diet low in fat and high in carbohydrates; (2) frequent self-monitoring of body weight and food intake; and (3) high levels of regular physical activity. Ninety-one percent of Registry participants report using regular exercise, such as an hour a day of brisk walking, as a key weapon in their efforts to maintain their weight loss.\textsuperscript{23} Numerous other observational studies of successful long-term weight losers invariably point to regular exercise as a cornerstone of weight loss maintenance.\textsuperscript{22-25}

#### Body composition

Although exercise is certainly no panacea for the treatment of obesity, to measure its effect by a scale alone is unfair and probably misleading. Although exercise stimulates fat loss, it also produces gains in lean muscle mass that may affect the absolute amount of weight lost. Conversely, when weight is lost through dieting alone, up to 30% of the loss can be because of the loss of lean muscle mass.\textsuperscript{17,26}

Several large observational studies looking at thousands of subjects have shown that physical activity has a favorable effect on body fat distribution as measured by waist circumference, waist-to-hip, and waist-to-thigh circumference ratios. However, data from randomized controlled trials on the subject have been equivocal.\textsuperscript{14}

Results from short-term studies (<16 weeks), which tend to use relatively high (~9324 kcal/wk) levels of energy expenditure, reveal a reduction in body fat in proportion with the amount of exercise performed. However, longer randomized controlled trials (>26 weeks), which include a much lower average weekly energy expenditure (~4620 kcal/wk), typically have not resulted in a strong relation between physical activity and fat loss.\textsuperscript{27} In a well-controlled study by Wood et al,\textsuperscript{28} 131 obese men were randomly assigned to
a diet-only, exercise-only, or a cotemporal-sedentary control arm. After 1 year, the men in the diet-only arm lost more total weight (7.2 kg) on average than did the men in the exercise-only arm (4.0 kg). However, the men in the diet-only arm lost 1.3 kg of muscle mass whereas the exercisers gained 0.1 kg of muscle, making the actual difference in fat lost between the groups much smaller (5.9 vs 4.1 kg). Our data support the fact that there is a dose-response relation between exercise volume and amount of absolute weight lost, as well as improvements in body composite ion including measures of central obesity. The amount of lean body mass gained through aerobic exercise was related to exercise intensity rather than volume, but this finding needs to be confirmed by further study.29

The results of a small study comparing the effects of an intensive 6-month endurance exercise program on the body composition of 28 young (age 28.2 ± 2.4 years) and older (age 67.5 ± 5.8 years) men showed that typical measures of body composition may significantly underestimate the benefits of endurance exercise on body composition. Although there were only relatively small changes in weight, waist circumference, and waist-to-hip ratios, both groups had approximately a 20% reduction in their intraabdominal fat deposits when measured by computed tomography.30 These findings were confirmed in a recent randomized controlled trial studying the effects of a 12-month exercise program on 173 obese postmenopausal women.31

Health benefits

Although there are no data from randomized clinical trials looking at the relation between physical activity and mortality, there is a wealth of observational evidence supporting the idea that small amounts of regular physical activity can reduce all-cause, and particularly, cardiovascular mortality by 20% to 30%.32 Research from the Aerobics Center Longitudinal Study, a 24-year observational study involving nearly 26000 men followed for an average of 10 years at the Cooper Clinic in Dallas, showed that obese men who were cardiovascually fit (as measured by time to exhaustion on a treadmill test) had overall mortality and cardiovascular mortality rates nearly half that of normal-weight men who were unfit. Obese but physically fit subjects had overall mortality rates only moderately higher than normal-weight subjects who were also physically fit.33 Numerous other studies have suggested that physical activity—indeed, the effect of its effect on weight—has favorable effects on blood pressure, insulin resistance, lipid profiles, the severity of sleep apnea, and the incidences of colon cancer, breast cancer, osteoarthritis, and osteoporosis.7,8,10,28,34,55

When weight loss is taken into account, losses as small as 5% or 10% of initial body weight can produce substantial improvements in risk factors for cardiovascular disease and diabetes and can lead to a reduction or discontinuation of medications for these conditions.14 A recent study reiterated the dramatic effects that an exercise-based program can have on preventing the development of diabetes in an at-risk population. In the well-designed Diabetes Prevention Program Trial, 3234 nondiabetic subjects with an average BMI of 34 and elevated fasting and postload plasma glucose concentrations were randomly assigned to 1 of 3 arms: (1) a lifestyle modification program; (2) treatment with metformin; or (3) placebo. After an average follow-up of almost 3 years, participants in the lifestyle modification arm—a 16-lesson program advocating at least a 7% weight loss through a low-fat diet and at least 150 min/wk of regular exercise—had a 58% reduction in the incidence of developing overt diabetes when compared with the placebo arm. Metformin was more effective than placebo, but less so than the lifestyle modification program, resulting in a 31% reduction in the incidence of diabetes.56

Resistance training

Most studies examining the role of exercise in the management of obesity have focused on aerobic exercise. However, a few studies have evaluated the role of resistance training in both overweight and obese populations. Significant increases in lean body mass are a consistent finding in resistance training studies across all populations, thus resistance training alone is typically not considered an effective means of weight loss.17 When weight-lifting programs are combined with dietary energy restriction, the amount of absolute weight lost is typically unchanged or even attenuated when compared with subjects treated with diet or diet plus aerobic exercise.37–41

Despite its meager role in generating weight loss, resistance training has a favorable, and seemingly profound, effect on body composition in obese subjects who are losing weight through dietary restriction. In a meta-analysis of 28 exercise and diet studies, Garrow and Summerbell17 showed that for every 10 kg of weight lost through diet alone, 2.2 to 2.9 kg (22%-29%) will typically come from lean tissue. In an aggressive 12-week study that randomized 35 overweight men into either a control group or 1 of 3 dietary groups—diet only, diet plus aerobic exercise, and diet plus aerobic exercise and strength training—Kraemer et al11 showed that this diet-induced loss of fat-free mass could be nearly obliterated with the addition of a combined aerobic and strength training program. Whereas absolute weight loss was similar in all 3 groups over the 3-month period (−9.64, −8.99, and −9.90 kg) the percentage of fat mass lost was strikingly different between the groups with 69%, 78%, and 97% of the total weight lost coming from fat. Unfortunately, whereas many proponents of resistance training have claimed...
that increasing a subject’s percentage of fat-free mass can prevent the typical decline in the basal metabolic rate associated with weight loss, studies have not supported this hypothesis.38-42

The role of resistance training in modifying other markers of cardiovascular risk in overweight and obese subjects such as insulin resistance, visceral fat, inflammatory markers, endothelial function, and lipoprotein subfractions remains an area of active investigation and is the subject of ongoing work in our group and others. Results from early studies suggest that, as with traditional lipid parameters, improvements in glucose handling and inflammatory markers are more dependent on weight loss rather than exercise training itself.43-45

Exercise prescription in the management of obesity

Determining the optimal volume, intensity, and mode of exercise needed to promote weight loss, improve cardiovascular risk factors, and decrease mortality remains a major research question. Public health guidelines regarding exercise prescription have been in flux throughout the years.46 In 1978, the ACSM published its first position statement on the quantity and quality of exercise needed to develop and maintain fitness in adults. These guidelines recommended 15 to 60 minutes of moderate to vigorous (60%-90% of maximum heart rate reserve) activity 3 to 5 d/wk. In 1995, the Centers for Disease Control and ACSM made a joint statement that “every US adult should accumulate 30 minutes or more of moderate intensity physical activity on most, preferably all, days of the week,” a recommendation that was echoed by the Surgeon General 1 year later.47,48

Most recently, in 1998, the ACSM released its third position statement on exercise prescription for health and fitness; these recommendations call for 20 to 60 minutes of continuous or intermittent exercise (minimum of 10-minute bouts), 3 to 5 d/wk at an intensity of 40% to 85% of maximum heart rate reserve.49

From an exercise prescription standpoint, the preponderance of evidence on exercise and mortality in obese subjects suggests 2 things: (1) a dose-response relation exists between the volume of exercise and all-cause mortality; and (2) a weekly energy expenditure of at least 4200 kcal/wk, the equivalent of 60 to 80 minutes of moderate intensity activity, such as brisk walking, on a daily basis.51 This increased exercise requirement for weight maintenance for obese subjects is independently supported by several other studies as well as a recent consensus statement.52 Results from 2 of these studies suggest that the benefits of this volume of exercise on maintaining weight may decrease over time as subjects began to gain weight between 12 and 18 months despite self-reports of compliance with a high volume of exercise.51,52

For obese persons, similar benefits may be gained by performing several shorter bouts of exercise throughout the day. In a recent randomized trial, 148 sedentary obese were instructed either to walk for 40 continuous minutes 5 d/wk or to break the sessions up into four 10-minute walks throughout the day over 5 d/wk. After 18 months, subjects in each arm lost a similar amount of weight—with the amount of weight lost corresponding to the amount of exercise performed.54 Data are less convincing from 3 recent randomized trials comparing the weight loss and health benefits of a traditional aerobic exercise program with a “lifestyle activity” program in which obese or overweight subjects were encouraged to incorporate brief bouts of physical activity into their daily schedules, like walking short distances instead of driving or taking the stairs in favor of an elevator.55-57 It is still not clear whether lifestyle interventions alone produce significant improvements in body weight and other health parameters.

Summary

Current evidence suggests exercise alone is only minimally effective for weight loss in obese subjects. Whether this is because of an insufficient volume of exercise, a subtle compensatory increase in energy consumption with increased levels of exercise, or other factors remains unclear. However, exercise appears crucial in the successful maintenance of weight loss and in fostering cardiovascular health. Physically fit obese individuals have a cardiovascular risk profile that is more akin to that of thin, fit subjects than that of their obese, but sedentary, counterparts.52

Although a small amount of regular aerobic exercise—similar to the current ACSM guidelines—appears adequate to reap substantial health benefits, it is not enough to have any substantial effect on weight loss without a concurrent modification in diet. Available data from weight loss studies suggest that to have a
significant impact on their weight, obese subjects need to burn approximately 10,500 kcal/wk—the equivalent of walking or jogging 25 mile/wk or roughly 80 minutes of moderate aerobic activity on most days of the week. 22-25,51,52

Although more randomized trials are needed to determine the optimal amount of exercise required for weight loss, weight maintenance, and overall health, staunching the epidemic of obesity and its effects on the health of the US population will require a serious approach to encourage all of our patients—especially the obese—to participate in a structured program of daily physical activity. Based on observational data, the required dose of exercise will likely far exceed the current recommendations. If this is the case, national guidelines should be changed to reflect the need for more physical activity.

References


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