

The Role of Exercise as an Effective Weight-Management Intervention

TANAKA Kiyoji, Hunkyung Kim and Wojtek Chodzko-Zajko*

Over the past two to three decades the remarkable economic growth witnessed by Japan has resulted in a number of significant changes in lifestyle for the Japanese population. In the 1950s and 1960s most women in the workforce were employed in the agricultural sector, however, today women play a much more diversified role in the workforce. The number of farm jobs has decreased remarkably, and there has been a gradual shift away from manufacturing jobs to employment in the service industry, in which the majority of today's working women are employed.

For both men and women, automation has reduced the physical demands of the work place. Substantially easier job requirements, when coupled with reduced activity in everyday life, has reduced the energy demands associated with daily living. Many people have become accustomed to driving cars instead of walking or bicycling, riding elevators instead of taking the stairs, and relaxing by watching TV or playing computer games instead of playing sports or hiking. As a result of all of these factors, energy expenditure during work time as well as leisure has decreased. One consequence of this lower level of energy expenditure is that both men and women in the Japanese population are getting heavier and fatter. This tendency can be seen clearly not only in the middle-aged but in the old. It is very surprising to see that most Japanese currently eat five- to ten-percent less calories than 20 years ago, yet weigh three kilograms more.

Recently, epidemiological investigations have shown that a high accumulation of abdominal

(central) fat is associated with an increased risk of coronary heart disease (CHD) and a number of other medical conditions^{7,29)}. Among the medical problems associated with obesity are angina, myocardial infarction, sudden death, hypertension, stroke, type II diabetes, gout, cancer, sleep apnea, gallbladder disease, diaphoresis (excessive sweating), digestive distress, menstrual abnormalities, arthritis, infertility, and a number of potential social and psychological consequences in broad age segments. In addition, excessive abdominal fat has been shown to result in metabolic complications such as glucose intolerance, hyperinsulinemia, and an abnormal lipid profile (increased triglycerides, reduced high-density lipoprotein cholesterol)^{7,29)}. Furthermore, obesity and possibly overweight also is a major cause of osteoarthritis, a progressive, irreversible form of arthritis characterized by degeneration of the articular surfaces of the joint.

The adverse consequences of obesity are not restricted to a single segment of the population, rather, obesity is known to result in serious medical complications for individuals of all ages. Although there is a consensus that obesity is associated with significant morbidity, there is less agreement about the exact definition of obesity or the point at which excessive fatness begins to constitute a serious medical concern. However, there is little doubt that obesity is a serious threat to an individual's health and well-being and that its consequences place a significant burden on the healthcare system.

In Japan, the incidence of obesity has more than tripled during the last two decades, and it is estimated that the prevalence is still increas-

* School of Exercise, Leisure, and Sport, Kent State University, Ohio, U.S.A.

ing. The economic, medical, and psychological costs to our society are considerable. It is clearly in the interest of society to develop effective interventions for the prevention and treatment of obesity. Not only in Western societies but also in Japan and some other Eastern societies, many overweight men and women are reaching out to the medical and health professions for help.

A number of effective forms of treatment interventions for obesity have been proposed. These include fasting, dieting, exercise (increased physical activity), behavioral modification, psychotherapy, drugs, and surgery, or some combination of these. With all forms of treatment, the major problem is a lack of total commitment on the part of the obese person. Consequently, the treatment of obesity is very complex. In this review, the authors attempt to suggest four types of weight-management intervention. In particular, the importance of a combined program of exercise and dieting will be emphasized.

IMPLICATIONS OF OVERWEIGHT

Nowadays, in Japan, there is a growing number of men and women who are overweight on the basis of the standard height-weight tables. However, height-weight tables are not always an accurate measure of body composition, and many athletes such as football and baseball players can weigh more than the ideal weight calculated from height-weight tables and still be both healthy and lean. Height-weight tables are especially inaccurate for the assessment of body composition in athletes who use resistance training to increase muscle mass and strength. There are also non-athletes for whom height-weight tables do not accurately assess body fatness. These individuals may fall within the prescribed range of weights for their height and frame size, yet have more than a normal or excessive amount of body fat. For the most part, such individuals are overeaters and/or sedentary. However, the opposite can also be true; for example, some individuals with a larger amount of body fat are physically active and eat less. Thus, etiology of obesity or over-

weight is complicated and can not be entirely accounted for by lifestyle factors.

By definition, overweight simply implies that an individual exceeds a range of weights specified by gender, height, and frame size. However, as discussed above, tables for determining ideal or desirable weight are not as accurate as experimental techniques. Consequently, it is important to individually evaluate each person's body composition and not to be overly concerned with whether that individual is overweight, underweight, or of normal weight as determined by norms or standard tables⁴⁶.

DEFINITION OF OBESITY

Obesity is a common clinical problem and is defined as the state of excessive fatness. The essential pathology of obesity is an increase in the size and/or number of the adipose tissue cells in the body. The National Institutes of Health Consensus Development Panel³³ defines obesity as "an excess of body fat frequently resulting in a significant impairment of health," which is associated with reduced longevity and increased incidence of cardiovascular disease, diabetes mellitus, osteoarthritis, and certain types of cancer as well as adverse psychological changes. It is generally accepted that genetic, hormonal, and metabolic factors play an etiological role in the development of obesity, while a long-term imbalance between energy intake and energy expenditure is the major pathophysiological disturbance that results in increased fatness.

Whether fatness is excessive or not is usually determined by assessing the proportion of fat to other tissues in the body. However, the percent of fat distribution differs between the sexes and varies as a function of age. Heredity is not necessarily a direct predictor of obesity, but it is clear that inherited differences exist in the susceptibility to become obese under given behavioral and lifestyle conditions. In both men and women, middle age is associated with increasing fatness. In women, fatness may increase following pregnancy or with the onset of menopause;

while in men it may be a feature of the fourth or fifth decade of life. Unfortunately however, there is no consensus on either the 'ideal' amount of fat, or the degree of fat deposition which is considered "normal".

CONSEQUENCES OF LONG-TERM OBESITY

The management of total body weight and body fat is an important component of overall physical health and it has a significant impact on the quality of life. Strictly speaking, it is not total body weight that affects health and appearance; but rather it is excessive body fat which is the risk factor for health. Thus, it is the body fat component, not total body weight, that needs to be reduced. In contrast, fat-free or muscle-mass component should be increased and/or maintained.

Paradoxically, there are also some advantages of being obese. Long-term obesity is likely to affect bone density, muscle mass, and cardiac size due to the increased total body weight and blood volume the body system has to support, and these will contribute to an increase in fat-free mass. It was calculated by Forbes and Welle¹⁷⁾ that 40% of the excess body mass index was due to the increase in lean tissue or fat-free mass. Garrow¹⁸⁾ estimates, for every 1kg gain in body mass associated with obesity, 25% of the increase is fat-free tissue.

As indicated in the previous sections, it is very clear that long-term obesity is associated with increases in both morbidity and mortality. The risk associated with overweight/obesity is curvilinear. Bray⁹⁾ demonstrated a tight relationship between body mass index and mortality. For those aged 40 to 69 years, severe obesity is associated with an increased mortality from a wide range of disorders^{3,4,28)}. It should be noted, however, that excessive underweight is not necessarily associated with good health, and that being mildly to moderately overweight is associated with little increment in mortality.

GENETIC EFFECTS OF OBESITY

In some strains of rodent (e.g., Zucker rats), obesity seems to be genetically pre-determined. Johnson et al.²⁵⁾ suggest that, although obesity can be modified by feeding, the tendency to obesity still emerges. In humans, epidemiologic studies suggest that there is a significantly positive relation between physical inactivity and obesity. In the U.S., the prevalence of obesity has doubled since 1900 despite a 10% reduction in energy intake. In Japan, it has tripled only during the last two decades. These data do not support the general belief that obese people consume more than do their leaner counterparts. Six studies found no significant difference in energy intake between obese and non-obese individuals, and five studies reported that the obese ate significantly less than did their non-obese peers⁴⁰⁾. Thus, contrary to popular belief, obese people often eat similar amounts or even less than leaner people over a broad age range as they become less active and slowly gain weight¹⁶⁾. The available evidence implies the significant role of genetic factors in the formation of obesity.

Mueller³²⁾ strongly suggests that, based on data from genetic analyses, the distribution of fat patterns may be inherited. Studies by Brook et al.¹⁰⁾ and Borjeson³⁾ on monozygotic and dizygotic obese and non-obese twins clearly show a remarkable concordance of the inheritance of fat patterns in twins. Other studies^{42,44)} have reported that skin-folds of newborn babies of obese mothers were thicker than babies of thin mothers.

With respect to energy expenditure, it was found that children of obese parents had a lower resting metabolic rate than children of non-obese parents²²⁾, suggesting that the not-yet-obese children had inherited a 'thrifty gene' from their obese parents. Garrow¹⁸⁾ notes that, from a therapeutic viewpoint, it is useful to know the existence of a genetic component to obesity, however he suggests that the overall impact of the genetic component is relatively small and that normal weight can be achieved with suitable life-style modifications.

MANAGEMENT OF OBESITY: GENERAL VIEW

For persons who are overweight it is important to emphasize the need for weight reduction and exercise training along with appropriate dietary recommendations, behavior modification, and/or psychological counseling. Obesity management has two important aspects: (1) fat loss for those individuals who are remarkably over-fat, and (2) prevention of further or future fat gain for everyone except the extremely under-fat person.

Among the lifestyle changes recommended for the management of body fat are; exercising regularly, maintaining a relatively low-fat diet, quitting smoking, and adhering to lipid-lowering medications if required. It should be born in mind that obese persons tend to be poorly motivated to participate in exercise programs. Such factors as shame and embarrassment at bodily exposure, real or imagined negative attention or ridicule from those fitter than themselves, and anxiety about time taken away from family or other pleasurable activities often contribute to negative attitudes towards exercise and physical activity²⁷⁾. Although effective management of obesity is often difficult, every effort should be made to reinforce healthy lifestyle habits such as exercise and good nutrition.

Over-fat cardiac patients should be encouraged to lose body mass by as much as 4.5kg (10 lb) in order to improve risk factors associated with CHD, such as blood pressure, serum lipids, etc^{13,14)}. Patients should be cautioned to lose only as much fat as they can comfortably maintain. Drastic limitations of food items must be avoided. In general, gradual dietary changes will often be better maintained than 'rapid weight loss' or 'crash' diets. Although many persons gain fat upon cessation of smoking, they should be reminded that the health risks of continuing to smoke far outweigh the addition of a few kilograms of body mass.

In Japan, some people attempt to lose weight because they perceive obesity to be a major health risk. Most, however, are motivated by the belief

that being overweight (or over-fat) is unattractive, and carries a social stigma. In the following section, the importance and effectiveness of weight-management intervention based on exercise and diet-plus-exercise will be discussed.

FOUR TYPES OF WEIGHT-MANAGEMENT INTERVENTION:

Cognitive-Behavioral Therapy.

Preventive medicine has become one of the most important weapons in the treatment of chronic disease and other health disorders in the latter half of the twentieth century. Much effort has been directed toward the development and implementation of good health habits. With respect to obesity, there is a need to assist over-weight persons learn how to change their behavior. The authors believe, in general, that strong will power is indispensable for successful weight management. However, failure in treating obesity should not be automatically attributed to a lack of will power or personal deficits due to the complex physiologic, genetic, cultural, and psychological factors which contribute to the development of obesity. Individuals who are identified early as at risk for particular disorders may need to learn how to cope psychologically with their risk status and how to change their modifiable risk-relevant behaviors.

Fasting.

Fasting is defined as abstention from food and liquids. Fasting is usually combined with other weight-management techniques (e.g., surgery, appetite-suppressing drugs, exercise, or behavior-modification) as a treatment for obesity. Typically, the obese individual severely restricts food and beverage intake over a period of a few days to one week, sometimes consuming little besides low-energy liquids. Such low-energy liquids of approximately 200 to 300 kcal each consist primarily of protein and some carbohydrates with carefully balanced vitamins and minerals. When successfully continued, dramatic

early weight losses can be attained in most obese individuals, regardless of gender, age, or the degree of obesity. It should be noted, however, that severe fasting often has an adverse impact on overall health status.

Fasting for extended periods of time is clearly not a healthy way to lose weight. While fasting can lead to large weight losses in severely overweight persons, as much as 50 percent of the weight loss comes from fat-free or lean mass. This is an undesirable outcome. Prolonged or severe fasting also has been reported to cause severe degenerative changes in cardiac muscle. Studies examining long-term weight maintenance following a fast are disappointing, since the weight lost during a fast is typically quickly regained. Starvation or fasting diets are no longer considered a safe or acceptable method of weight loss in the medical community. Therefore, other types of weight-management interventions are strongly recommended, particularly dieting, exercise, and cognitive-behavioral techniques.

Dieting.

Recent household food expenditures in Japan reveal a marked decline in spending on rice and an increase in spending on ready-to-eat foods and dining out. This may be due to a sharp increase in the number of wives working, which is one of the most prevalent recent changes in the national lifestyle. The following dietary protocol is recommended by the American Dietetic Association and the American Diabetes Association in the U.S., and by the Ministry of Health and Welfare in Japan. A nutritionally balanced diet consists of approximately 50% carbohydrate, 27% protein, and 23% fat.

A very low-calorie diet which has become popular in recent years, involves fasting supplemented by either a powdered supplement or small amounts of fish or fowl. The reason why a powdered supplement such as Micro Diet became quite popular is very simple. This is because; (1) dieters do not have to make choices about foods, and (2) because dieters can take it whenever and

wherever necessary without consideration of calories and nutrients. Adequate nutrition and a decreased energy intake relative to energy expenditure (i.e., negative energy balance) are the general goals of most dietary interventions.

Gordon and Mitchell²¹⁾ have summarized several health-related factors that need to be considered when prescribing exercise for persons who are dieting. When an individual is on an energy-restricted diet, care should be taken to ensure that adequate carbohydrates are consumed to replenish muscle glycogen stores because they may be depleted during exercise. Resistance training or a combination of aerobic and resistance training may be of particular benefit when it comes to preserving fat-free body mass and minimizing a decline in basal (or resting) metabolic rate during dieting.

Exercise.

Exercise has many advantages in the management of over-weight. Brownell and Grilo¹¹⁾ recommend exercise as a treatment for obesity and over-weight for the following reasons: 1) The cumulative effects of exercise on energy expenditure over long periods of time can be substantial. 2) Exercise prior to a meal can help to suppress appetite in some persons. 3) Exercise can counteract the adverse effects of obesity and promote health status independent of weight loss. 4) Exercise can improve psychological functioning. 5) Exercise can minimize the loss of fat-free mass. 6) Exercise may counter the metabolic decline produced by dieting.

The American College of Sports Medicine²⁾ provides the following guidelines for exercise prescription for obesity treatment and weight maintenance. 1) Mode of Exercise - Walking. Alternative modes includes stair climbing, cycling, and water exercise. 2) Intensity of Exercise - Low end of target heart rate range (i.e., 50-60% $\dot{V}O_{2max}$). 3) Duration of Exercise - Sufficient to cause energy expenditure of 200 to 300 kcal per session. 4) Frequency of Exercise - At least three times a week. 5) Precaution 1 -

Avoid excessive stress on joints. 6) Precaution 2 - Choose a setting that minimizes social stigma. 7) Precaution 3 - Monitor muscle soreness and orthopedic problems. Most obese individuals are encouraged to perform a relatively lower intensity, longer duration of aerobic exercise in order to meet the energy expenditure goal of 200 to 300 kcal/session or more if possible, which should correspond to approximately 1,000 to 2,000 kcal/wk²⁾.

Cross-training (rotation of exercise modalities) may be the best choice to prevent injuries and to enhance motor skill development, because many obese individuals have had a long sedentary past and are therefore at an increased risk for orthopedic injury³¹⁾. Light to moderate exercise such as progressively increasing volumes of walking, jogging, biking, tennis, swimming, or dancing can be an effective method of treatment for obese persons, particularly if it is combined with appropriate dietary restriction. In general, the larger the number of muscle groups activated in the exercise session the more effective the program is likely to be. A combination workout consisting of 15- to 20-min sitting and 20- to 30-min standing exercises for strength-building, endurance, flexibility, coordination, and balance is strongly recommended.

Exercise adherence is now commonly cited as the strongest predictor of long-term success in weight management. In a recent study, weight maintainers, relapsers (weight regainers) and individuals who had never been obese were compared²⁶⁾. One of the most striking findings in this study was that most maintainers (90 percent) and women who never had a weight problem (82 percent) reported exercising regularly (at least three times per week). In contrast, only 34 percent of relapsers reported regular exercise, and those who did, trained less frequently and at lower intensities than the weight maintainers.

With the increasing interest in leisure, spending on travel, sports, entertainment and hobbies has also been increasing in recent years. This means there are a large variety of oppor-

tunities for enjoying exercise or physical activity. Obese persons are recommended to find several choices for exercise and physical activity that can be maintained for a long period of time as a life-long hobby.

Pavlou and colleagues³⁵⁾ examined the role that exercise played in helping a group of slightly overweight police officers both lose and manage their weight. The subjects were randomly assigned to one of four diet conditions and to either an exercise (90 minutes of supervised exercise, three times per week) or non-exercise condition. After eight weeks of dieting, there were no differences between the diet-alone and diet-plus-exercise subjects. However, eighteen months after treatment, the non-exercisers had regained all of their weight, whereas the exercisers had maintained their weight loss. This stresses the need for adding an exercise or physical activity component to the weight-maintenance phase of any weight-management program.

Most studies have examined aerobic exercise as the physical activity mode in weight reduction studies, which by itself is not known to result in gains in FFM^{16,20,37)}. Resistance weight training, which has been shown to result in gains in FFM^{19,30,45)} has been shown to elicit maintenance and/or increases of FFM during dietary-induced weight loss. The role of resistance training as a means for weight management requires further investigations.

The Combined Effect of Exercise and Dieting.

It is possible to attain a reduction in body fatness through exercise without concurrent energy restriction. However, the degree of fat reduction is often less than optimal. The exercise only regimen is recommended only for those who are young, mildly obese, and have had previous experience with exercise.

Weight loss induced by moderate/severe restriction of energy intake generally results in loss of both fat and fat-free mass (FFM) with the percentage lost as FFM increasing relative to the severity of the deficit in food and drink.

For example, losses of FFM expressed as a percent of total weight lost have ranged from as little as 15% for mild energy restriction to as high as 50-70% during semi-starvation diets^{5,12}.

Ideally, the negative energy balance induced by exercise in combination with energy restriction appears to minimize losses of FFM. Numerous researchers^{12,43,47} have reported maintenance of FFM with exercise compared with diet-only controls. In our own research, computer-assisted tomography indicates that 'diet plus exercise' produces greatest loss in visceral fat as well as in subcutaneous fat³⁸. For both overweight men and women, body weight loss was greater for the diet-plus-exercise group when compared to diet alone and exercise alone groups³⁸.

Hagan et al.²⁴ found that a 1,200 kcal/d diet will produce weight loss and when combined with 5 d/wk of aerobic conditioning for 12 weeks will produce a greater decrease in body weight and fat weight compared to the same diet alone. Very similar results were obtained in Japanese obese women³⁹. Our findings support the view of Epstein and Wing¹⁶ that weight loss due to exercise alone will be minimal compared to that associated with dietary restriction and dietary restriction combined with exercise.

DISCUSSION

Only in the last 20 years has the medical community come to recognize the critical role of exercise in weight control. In 1975, it was stated in Harrison's Principles of Internal Medicine⁴¹, a highly respected medical reference, that although exercise was a good method to increase energy loss for weight reduction, inducing obese subjects to exercise was very difficult, particularly for any length of time. Though excellent for the psyche and the circulation, for most obese persons exercise was deemed minimal in its overall energy effect, when compared to a reduction in caloric intake. Medicine has certainly changed its stand! The 1991 edition of the same reference emphatically states that exercise has a place in any weight reduction program and

that incorporation of regular exercise into an overall weight reduction program will improve the chances that an obese person will maintain the weight loss³⁴.

In a state of equilibrium energy intake equals the energy expenditure. Imbalances necessarily result in weight gain or weight loss: If the energy intake exceeds the energy expenditure the person is in positive balance (weight gain); while if the energy expenditure is larger than the energy intake, a negative balance (weight loss) is achieved. The successful prevention and treatment of obesity is dependent on an understanding of the energy balance systems and the incorporation of this knowledge into intervention strategies. Fasting or dieting should be supplemented, with maintenance strategies designed to help the individual keep weight off.

Although fasting or severe dieting is the most efficient way to lose fat, it also results in a significant loss of fat-free mass. Severe protein malnutrition can result in muscle wasting and other health problems, for these reasons fasting is often a less than ideal solution for the treatment of obesity. Evidence suggests that exercise in conjunction with other treatments produces more effective weight loss than do single intervention strategies^{15,23,24,36}.

National nutrition surveys show that, after 1975, the Japanese people's energy and carbohydrate intakes decreased and leveled off after 1990. The energy intake was approximately 2,226 kcal in 1975 and 2,042 kcal in 1995. Today's energy intake of approximately 2,000 kcal is said to be at just about the right level. Intake of animal protein, fat, and animal fat which had been increasing has leveled off. Calcium intake is still below the necessary amount. This is the only nutrient that does not meet the recommended level for Japanese.

Despite the leveling-off of total energy intake, the number of obese men and women is increasing every year. This is primarily due to decreases in energy expenditure resulting from lower levels of daily physical activity (i.e., posi-

tive energy balance). As a result, the average weight of 20-year-old males, which was 59.6 kg in 1971, increased to 64.1 kg by 1995. In sharp contrast, the average height of 20-year-old males, which was 169.0 cm in 1971, increased only to 171.1 cm by 1995. Thus, the average increase of height was 1.1 cm, while the average increase of weight was 4.5 kg. However, the average height of females increased from 156.8 cm to 158.4 cm in the same period, and the average weight remained almost unchanged (51.3 kg and 51.2 kg, respectively). The much greater change seen in the average weight than in the average height of the males is attributed to a significantly reduced amount of physical activity in their daily lives.

Although the reason why the average weight of females has not changed during this period is not known, an increase in the number of females who wish to restrict diet may be one possible factor. The U.S. National Center for Health Statistics surveys show that nearly 50% of adult women in the U.S. report that they are dieting to lose weight. The dieting trend is even more prevalent in teen-aged girls with 60–75% reporting that they are dieting to lose weight.

We conclude with some comments about combined exercise and diet prescriptions for persons who are very over-fat. Most exercise nutrition scientists and health care professionals agree that people who are obese should be encouraged to lose weight through a combination exercise-plus-diet program. However, it must be recognized (1) that it is unrealistic to expect all individuals to develop a thin figure, (2) that thinner is not necessarily healthier, and (3) that humans vary with respect to body composition¹⁾. Health professionals or exercise leaders should obtain information concerning past exercise history, potential scheduling difficulties, and the locations where exercise might be performed (e.g., fitness club, home, street, park, school gym, etc.). Information about self-esteem and general psychological well-being is also useful because lack of willpower and poor self-concept is often

associated with weight control problems¹⁾. The prescription of low-intensity, low-impact exercise together with a low to moderate calorie diet provides for the possibility of scheduling an intervention on a daily basis, thereby resulting in the maintenance of a continuous cycle of negative energy balance.

CONCLUSION

Despite the well-known health consequences of obesity, increased public concern, and high rates of dieting, obesity remains a common problem. In the twenty-first century, it will be increasingly important for health scientists to develop effective interventions which are able to promote preventive health behaviors. In particular, relapse prevention strategies are needed to assist obese individuals from returning to their previous health-compromising lifestyles.

Studies have shown (1) that body weight and body fat is under substantial genetic control, (2) that the pattern of body fat distribution is also genetically influenced, and (3) resting metabolic rate is also somewhat influenced by genetics. It is also clear that these attributes can vary considerably across individuals. Therefore, the health professional should explain to overweight people that they inherit only a tendency towards obesity and that the extent of its expression can to a great extent be influenced by lifestyle factors such as, diet and/or exercise, as well as by behavior modification, cognitions, and social support. There is growing evidence to suggest that regular exercise, either alone or in combination with dietary modifications, can have an important role in the prevention and treatment of obesity.

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