PHYSICAL FITNESS AND THE *HEALTHY PEOPLE 2000* GOALS

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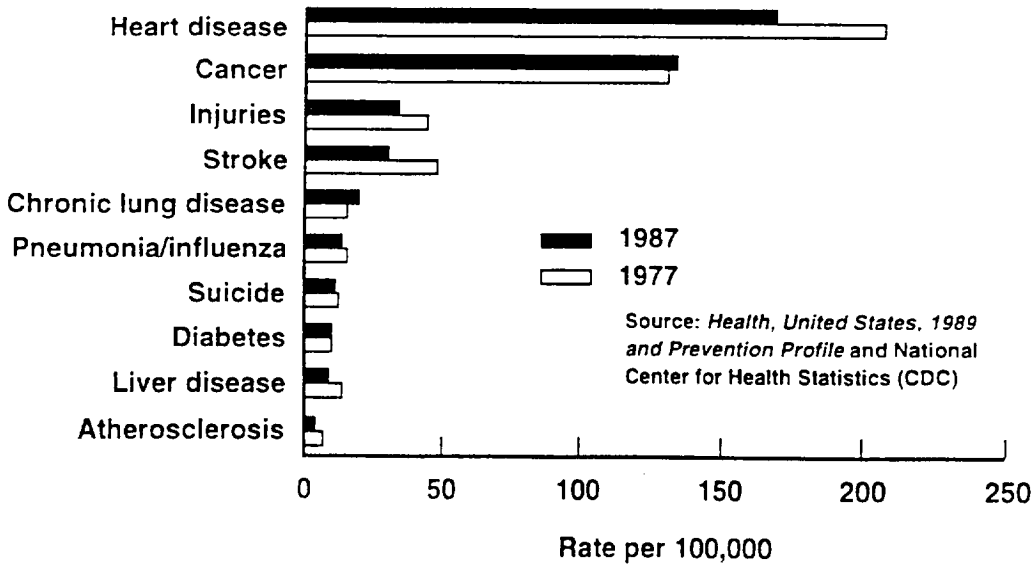
Healthy People 2000 is a statement of national objectives with the overall goal of improving American health.[1] It grew out of a 1979 report from the Surgeon General's Office which developed into a listing of objectives for the 1980's. In 1987, the U.S. Public Health Service of the Department of Human Services sponsored a national consortium with participation of all State Health Departments, the Institute of Medicine of the National Academy of Sciences, and the Secretary's Council on Health Promotion and Disease Prevention. Eight regional meetings heard testimony and studied documents from thousands of sources to determine how the nation's health was progressing and to develop tactics for improving health through the 1990's. They learned that over a 10-year period the nation's principal killers had become slightly less lethal (with the exception of cancer). Exhibit 1 shows the leading causes of death in the U.S. population.

Exhibit 1. Leading Causes of Death
U.S. Population (Age Adjusted)



They also found that the cost of surviving a catastrophic health event had grown beyond the reach of all but the wealthy and near-wealthy (i.e., those with medical insurance and lots of extra savings). They learned that people of lower economic privilege either suffer and die early or the taxpayers pick up the medical bill.

Exhibit 2. Costs of Treatment for Selected Preventable Conditions

Condition	Overall Magnitude	Avoidable Intervention	Cost Per Patient
Heart Disease	7 Million With Coronary Artery Disease	Coronary Bypass Surgery	$30,000
	500,000 Deaths Per Year		
	284,000 Bypass Procedures Per Year		
Cancer	1 Million New Cases Per Year	Lung Cancer Treatment	$29,000
	510,000 Deaths Per Year	Cervical Cancer Treatment	$28,000
Stroke	600,000 Strokes Per Year	Hemiplegia Treatment and Rehabilitation	$22,000
	150,000 Deaths Per Year		

Recognizing that our deadliest and costliest diseases are preventable, *Healthy People 2000* released its goals and facilitating targets to promote healthy habits which help prevent disease and lower health care costs on a national level. The three broad

goals are to (1) increase the span of healthy life for Americans, (2) reduce health disparities among Americans, and (3) achieve access to preventive services for all Americans.

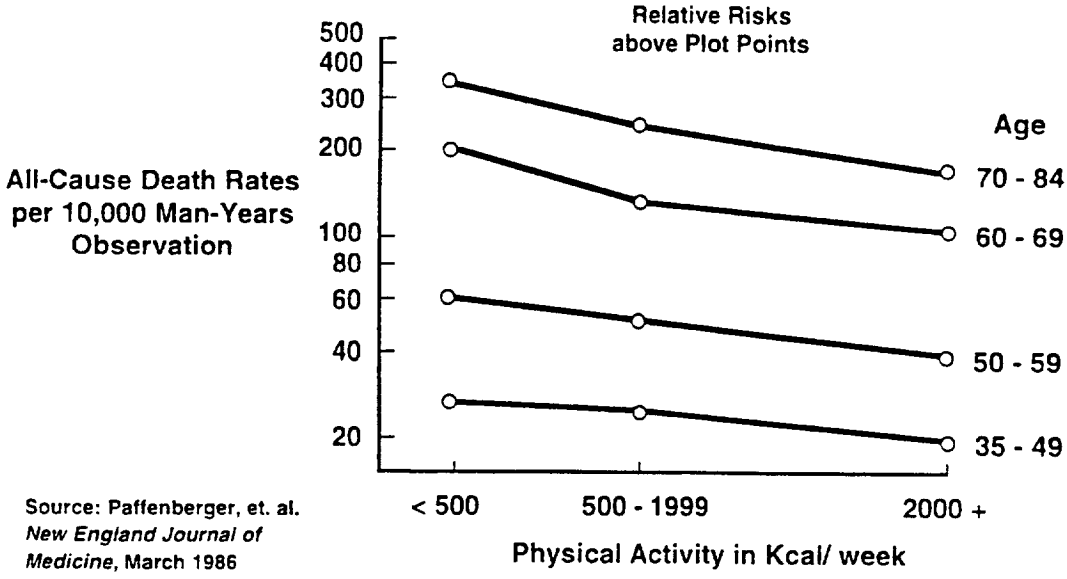
Plans for achieving the goals were defined by 22 priority areas with specific objectives to be accomplished by the turn of the century. These 22 priority areas are shown in Exhibit 3. It is highly informative that the first objective listed as top priority for health promotion is physical activity and fitness. The focus and purpose of this presentation is to explain the role of exercise and physical fitness in reaching the *Healthy People 2000* goals.

Exhibit 3. *Healthy People 2000* Priority Areas

- **Health Promotion**
  - Physical activity and fitness
  - Nutrition
  - Tobacco
  - Alcohol and other drugs
  - Family planning
  - Mental health and mental disorders
  - Violent and abusive behavior
- **Health Protection**
  - Educational and community-based programs
  - Unintentional injuries
  - Occupational safety and health
  - Environmental health
  - Food and drug safety
  - Oral health
- **Preventive Services**
  - Maternal and infant health
  - Heart disease and stroke
  - Cancer
  - Diabetes and chronic disabling conditions
  - HIV infection
  - Sexually transmitted diseases
  - Immunization and infectious disease
  - Clinical preventive services

Nutrition was the second listed priority. Without proper nutrition, health-related fitness is simply not achievable. A recent Gallop poll reported that physically active people have better nutritional habits than people who are sedentary. Non-use of tobacco is also the norm among the physically active. We published a study on exercise adherence in *Sports Medicine* in 1989[2] showing that smokers as a group rarely enroll in exercise programs, and the smoking habit was identified as the chief factor contributing to early drop-out. We also learned that, of the few smokers who continued exercising in the Johnson Space Center (JSC) Health-Related Fitness Program for a period of at least two years, 100 percent quit smoking. Other researchers report a lower incidence of alcohol abuse among physically active people. The physically active are also less afflicted by psychological stress. In fact, physical exercise at a moderate intensity is an effective therapy for lowering depression and anxiety. The point is that the influence exercise has on health is not entirely independent. It is also due to its interaction with other health habits: proper nutrition, abstention from tobacco, and moderate alcohol consumption. The long-term pattern of physical activity actually helps us live longer, as can be seen in Exhibit 4.[3]

Exhibit 4. Age-Specific Mortality (All Causes) Versus Physical Activity Levels



Source: Paffenberger, et. al. *New England Journal of Medicine*, March 1986

Dr. Paffenbarger of Stanford reported in a 1986 issue of the *New England Journal of Medicine*[3] that exercisers live longer than non-exercisers, and those who exercise a lot live longer than those who exercise a little. In other words, exercise reduces the mortality risk. The optimum effect is achieved from a weekly exercise regimen consuming 2,000 kilocalories or more, which is equivalent to jogging 15 to 20 miles or walking 20 to 30 miles per week. From this amount of exercise the projected life expectancy is increased by an average of two years. Two years may not seem like much unless compared with the projected increase in life expectancy with the eradication of cancer -- another two years.

Diseases and disorders related to physical activity include:

- Heart Disease
- Hypertension
- Diabetes
- Osteoporosis
- Cancer
- Stroke
- Chronic Backache
- Obesity

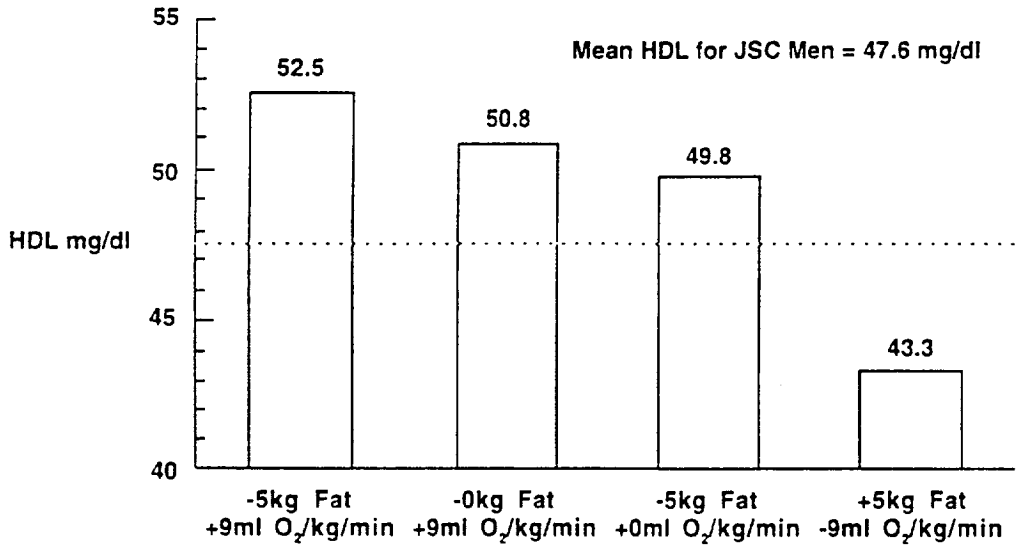
Exercise helps increase the life span by lowering the risk of fatal diseases. The first health status objective assigned by *Healthy People 2000* is the reduction of coronary heart disease by increasing physical activity. The value of exercise for preventing hypertension, stroke, diabetes, and osteoporosis and for rehabilitating the victims is also known. Recent research has also implicated physical activity in reducing the incidence of various forms of cancer. Workforce studies show that physical activity on the job reduces by half the incidence of colon cancer, and an impressive longitudinal study[4] on 5,300 women showed that a vigorous activity habit established early in life cut the risk of breast cancer by one-half and reproductive system cancer by two-thirds. The activity habit also lowers the risk of disability from chronic backache, which is the leading factor in industrial absenteeism. Also, exercise is the key to achieving and maintaining a healthy body weight.

The multifactorial nature of disease and the interrelationship of exercise with other factors makes it very difficult to explain the physiologic and biochemical mechanisms. Two exercise factors have been exposed in both cross-sectional and longitudinal research

as markers of health: aerobic capacity and body composition. Aerobic capacity is a person's maximal capacity for processing oxygen which is required for persistent work. Body composition is the division of body weight into fat and lean components and expressing them as a percentage (i.e., percent fat).

Several years ago we published a report[5] on the response of HDL-cholesterol to changes in aerobic capacity and fat weight (see Exhibit 5).

Exhibit 5. Increase Aerobic Capacity and Decrease Fat Weight to Optimally Increase HDL-Cholesterol

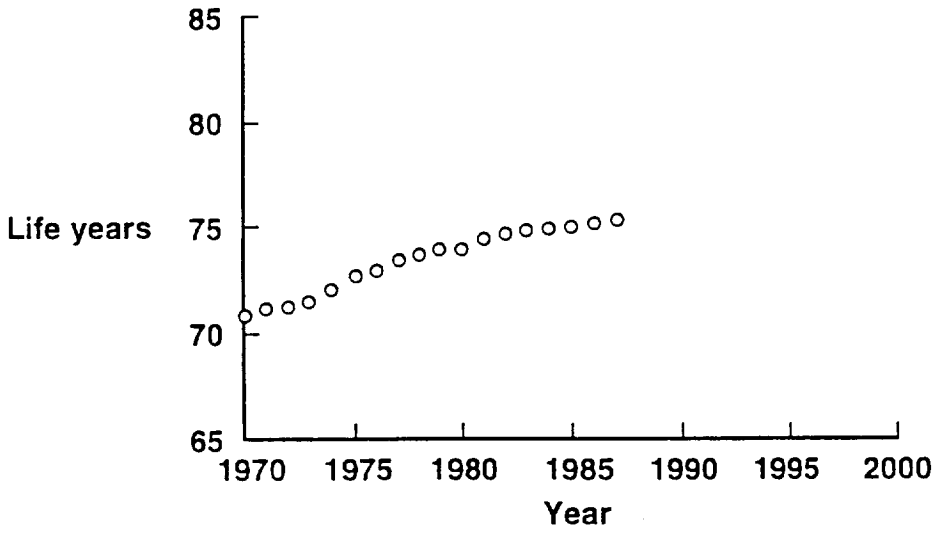


HDL-cholesterol is the cholesterol constituent with anti-atherogenic properties. The higher the HDL count in a sample of blood, the lower the risk for heart disease. Our study drew on data from men enrolled in the Health-Related Fitness Program at the JSC. On average, they were about 43 years old. Among other appraisals we measured their aerobic capacity, body composition, and blood lipids on two tests separated by about three years. The quantification of aerobic capacity is VO_2max, which expresses the volume of oxygen per unit of body weight that is consumed in the last minute of maximal effort test, normally performed on a treadmill. We learned that HDL-

cholesterol rises over time if (1) aerobic capacity goes up while fat weight remains constant, (2) fat weight goes down while aerobic capacity remains constant, or (3) fat weight goes down while aerobic capacity goes up -- this produces the greatest increase. It is important to recognize that a clinically significant change in HDL-cholesterol may require a dramatic fat loss and aerobic gain. Research shows that the beneficial change in HDL-cholesterol is delayed for about nine months and depends on exercise throughout that period equivalent to running 10 to 12 miles per week.

Life expectancy has gone up, due mostly to the eradication of lethal infectious diseases, reduction in the number of infant deaths and, more recently, the reduction in early heart attack deaths. Exhibit 6 shows life expectancy at birth of the U.S. population.

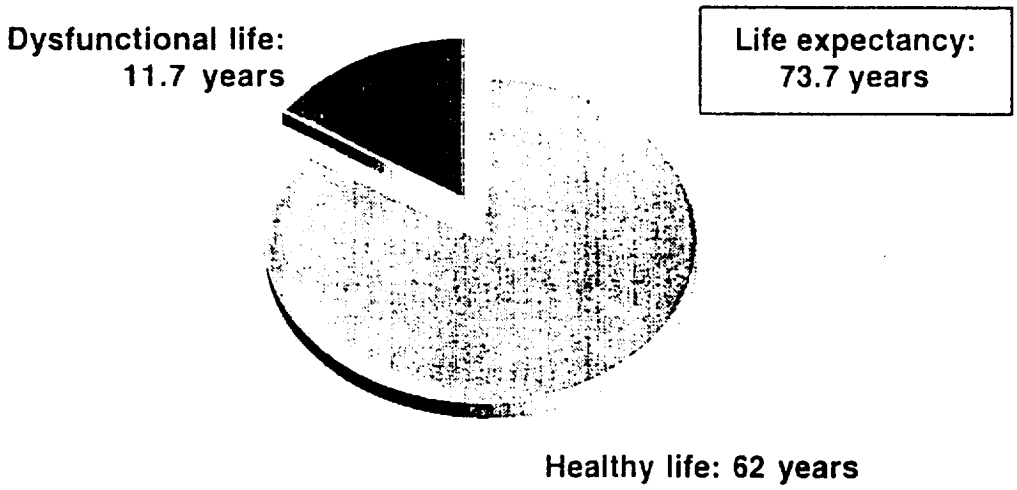
Exhibit 6. Life Expectancy at Birth, U.S. Population



Source: *Health, United States, 1989 and Prevention Profile*

Though medical science can claim a large share of the credit for keeping the average American alive longer, this does not mean that longer life is equated to longer health. People who reach age 65 can now expect to live into their eighties, but the last 12 years of remaining life are likely to be limited by sickness, weakness, and injury. Exhibit 7 shows years of healthy life as a proportion of life expectancy of the U.S. population.

Exhibit 7. Years of Healthy Life as a Proportion of Life Expectancy, U.S. Population (1980)



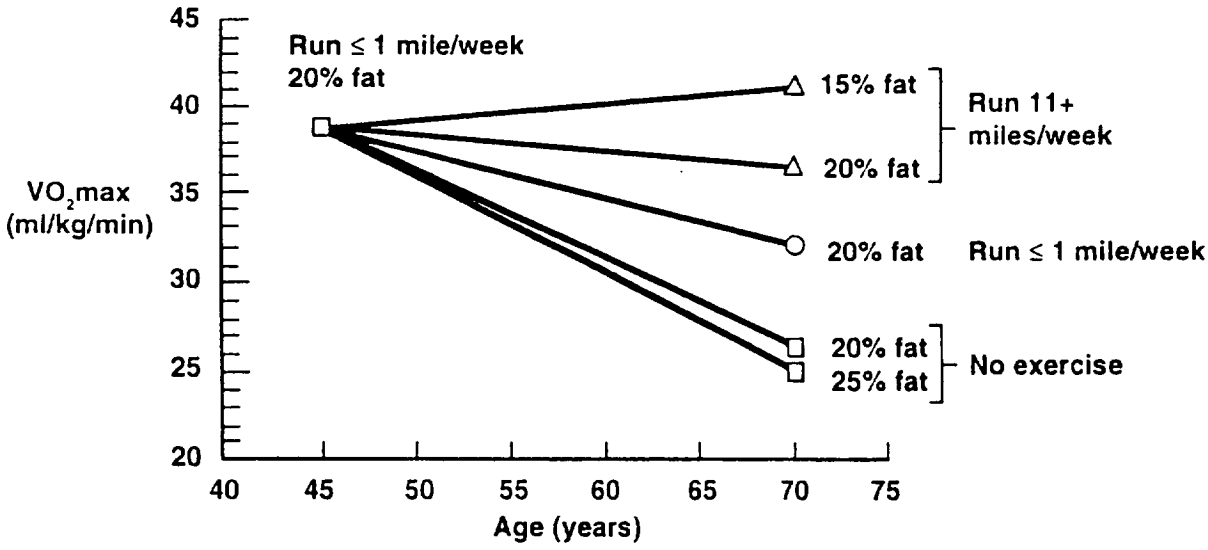
Source: National Vital Statistics System and National Health Interview Survey (CDC)

The elderly not only want a longer life, they also want to remain functionally independent. In other words, they want to retain the capacity to bathe and feed and care for themselves. To do this requires that they maintain their functional capacity. The most unarbitrary quantification of functional capacity is VO_2max. Agewise studies on VO_2max shows a yearly decline from about age 30. The average yearly decrease is

approximately 1/2 milliliter of oxygen per kilogram of body weight per year. Previous studies on aging and aerobic capacity failed to take other age-related changes into account. As a rule, people gain weight and become less active as they age. The decrease in aerobic capacity with aging may not be so much a function of the physiology of aging as the deterioration from reduced activity.

We recently completed an aging study on a large sample of men and women employed at the Johnson Space Center.[6,7] We developed a model for calculating the change in VO_2max with aging. Under the typical scenario of gradually reducing physical activity from age 45 to age 70, we found VO_2max falls at the rate reported in previous studies. However, if the activity level and body fat remain constant over 25 years, the VO_2max falls at only about half the rate (see Exhibit 8).

Exhibit 8. Change in VO_2max With Changes in Age, Percent Fat and Physical Activity



We also showed the potential for retaining or even increasing functional capacity over the years. The average weekly activity habit at age 45 for our employees was equivalent to exercising about 30 minutes or running about 1 mile. If that person increased the activity to an equivalence of running 11 or more miles per week, the functional capacity at age 70 would be about the same as it was 25 years previously. In fact, a higher functional capacity would actually be expected at age 70 if, in the process of increasing physical activity, the percent fat decreased.

The value of physical exercise is no secret. National polls show the American attitude toward exercise is quite favorable. Still, according to one poll, America's favorite activity is far from anything resembling physical activity. The national pastime is going out to eat, followed closely by watching television. The average American exercises very little if at all. Polls show that only about 22 percent of the adult population exercises at a moderate level -- equivalent to walking four or five times per week. No more than 10 percent of our adults exercise at an intensity, frequency, and duration appropriate for improving aerobic fitness. About 25 percent are completely sedentary.

The first priority of *Healthy People 2000* is to get the American population active. Exhibit 9 shows that our objective is to raise the level of moderate exercisers in the adult population from 22 percent to 30 percent by the turn of the century, double the proportion of vigorous exercisers from 10 percent to 20 percent, and drop the sedentary segment from 25 percent to 15 percent. To offset the potential for injury, at least 40 percent of the adult population should engage in strength and flexibility training.

Exhibit 9. Objectives for Physical Activity and Fitness

	Current	2000 Target
Moderate Activity (<60% VO_2max)	22%	30%
Vigorous Activity (>70% VO_2max)	10%	20%
No significant activity	25%	15%
Strength/Flexibility Training	No Data	40%

Under-exercise and over-nutrition share responsibility for the obesity epidemic in the United States. Some cross-population studies report that America is the fattest country in the world. By weight/height ratios, about 26 percent of adult Americans are overweight. By body composition standards, around 35 percent of the adult population is over-fat. Regardless of the standard used, the message is clear. The *Healthy People 2000* mission is to reduce overweight status to no more than 20 percent of the adult population (Exhibit 10). Additionally, by the year 2000 at least half of all overweight people should be on an exercise and diet program to attain healthy weight.

Exhibit 10. Objectives for Altering Overweight Status

	Current	2000 Target
Overweight Adults	26%	20%
Overweight People Combining Diet and Exercise to Attain a Healthy Weight	No Data	50%

What kind of exercise promotes fitness and health? The answer depends on an understanding of just what health-related fitness is. To the average person, physical fitness is a male professional athlete or a female New York model. Although these people may be healthy and fit, their principal activities -- sports and very low calorie diets -- do not promote fitness in a healthy sense. Perhaps the best way to explain health-related fitness is to define the operational components, each of which can be measured with objective tests and improved by specific activities. The components of health-related fitness are:

- o Cardiorespiratory Endurance
- o Body Composition
- o Muscle Strength and Endurance
- o Flexibility.

Cardiorespiratory endurance is the capacity of the heart, lungs, blood vessels, even the blood itself, to deliver oxygen to the muscles for relatively continuous work. It is quantified as VO_2max, and is positively related to the capacity for work and negatively related to risk for cardiovascular diseases.

Body composition is best described as the percentage of body weight which is fat weight. Over-fatness is a powerful and independent risk for a number of maladies such as cardiovascular diseases, cancers, diabetes, heat intolerance, and reduced physical performance.

Muscle strength is the capacity to exert force against resistance, and muscle endurance is the capacity to do so repeatedly. This component is more closely related to performance than to health. How strong one needs to be depends on what he/she does for a living and for fun. Lumberjacks and oil field workers must be strong or they will become injured on the job. Without adequate strength, weekend athletes will get hurt on the playing fields. For most Americans the ability to lift huge amounts of weight is not important for their jobs or for their sports. However, musculoskeletal injuries sideline more workers than any other single cause. Of major concern is the common backache which occurs most often because of weak and stiff muscles.

Put simply, flexibility is the capacity to bend, turn, twist, and stretch. This component is closely associated with muscle strength and endurance. Both components are highly related to physical activity and injury rate. Muscles that are not exercised shorten and stiffen. People who exercise the least suffer the more debilitating injuries, and they take longer to rehabilitate. A typical scenario work site involves a crew becoming progressively weaker over the years. Then the boss comes along and commands everyone to pitch in and clean up the storeroom for a short-notice inspection. The crew gets the job done, but a number of them cannot make it to work the next day due to the aches and strains that resulted from the weakness and stiffness that had progressed over time.

How can we become more fit and healthy without constantly being laid up by injury? For anyone who has not exercised for a long period of time, medical clearance should be obtained to ensure against latent disease or to adjust for anatomical or orthopedic anomalies. Screening by maximal treadmill test is recommended for people over age 40 or for those under 40 who have disease risk (abnormal resting ECG, smoking habit, obesity, high blood pressure, high serum cholesterol, diabetes mellitus, family history of heart disease).

A complete exercise program (Exhibit 11) describes a regimen for improving cardiorespiratory endurance, body composition, strength, and flexibility. The programs should overlap to reduce the injury risk.

Exhibit 11. The Exercise Program

- **Mode:** For each component, the plan takes into consideration the various modes of appropriate exercise.

- **Intensity:** Intensity describes the level of forcefulness needed to achieve a training effect while preventing over-stress.

- **Duration:** A description of how long each session lasts.

- **Frequency:** Frequency describes the number of sessions per week. If the exerciser hopes to improve without injury, the program must be regulated by gradual but steady progression.

Over the long term, the program should also allow for periods of rest.

Cardiorespiratory endurance activities must be the heart of the program because they offer the greatest contribution to health and longevity. Aerobic activities involve the large muscles of the body or they incorporate a number of large and smaller muscles working in synchrony. The activities should be done for lengthy periods at moderate to vigorous intensity. Controlling the intensity within the boundaries of safety and effectiveness is the most difficult task for the exerciser and the exercise director.

The American College of Sports Medicine (ACSM) recommends a training intensity between 60 percent and 90 percent of maximum heart rate,[8] or between 50 percent and 85 percent of VO_2max or heart rate maximum reserve (Exhibit 12). In June, 1992, we presented a paper at the Annual Meeting of the ACSM showing how difficult and potentially imprecise intensity regulation by VO_2 and heart rate methods really are in practice.[9]

Exhibit 12

ASCM Position Stand, Medicine and Science in Sports and Excercise (1990) Vol 22, p.265-274

The Recommended Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness in Healthy Adults

AMERICAN COLLEGE of SPORTS MEDICINE
POSITION STAND

2. Intensity of Training: 60-90% of maximum heart rate (HRmax), or 50-85% of Maximum Oxygen uptake (VO_2max) or HRmax reserve.[1]

This Position Stand replaces th
Recommended Quantity and Qua
Maintaining Fitness in Healthy A

Increasing numbers of
volved in endurance trai g and other forms of physical activity, and, th the need for guidelines for exercise prescriptio is apparent. Based on the existing evidence concer g exercise prescription for healthy adults and th need for guidelines, the American College of Sp s Medicine (ACSM) makes the following recomm dations for the quantity and quality of training f developing and maintaining cardiorespiratory fit ss, body composition, and muscular strength and durance in the healthy adult:

2. Intensity of training: 60–90% of maximum heart rate (HR_{max}), or 50–85% of maximum oxygen uptake ($\dot{V}O_{2max}$) or HR_{max} reserve.[1]

aerobic activity. Duration is dependent on the intensity of the activity; thus, lower intensity activity should be conducted over a longer period of time. Because of the

RATIONALE AND RESEARCH BACKGROUND

Introduction

The questions "How much exerci s enough," and "What type of exercise is bes for developing and maintaining fitness?" are frequently asked. It is recognized that the ter physical fitness" is composed of a variety of characteristics included in the broad categories of cardiovascular-respiratory fitness, body composition, muscular strength and endurance, and flexibility. In this context fitness is defined as the ability to perform moderate to vigorous levels of physical activity without undue fatigue and the capability of maintaining such ability throughout life (167). It is also recognized that the adaptive response to training is complex and includes peripheral, central, structural, and functional

A simpler means for controlling intensity is to use a scale of perceived exertion which was developed by Gunnar Borg[10] of Sweden (Exhibit 13). The scale ranges from zero to ten, and describes how a person feels when exercising aerobically. This subjective scale accounts not only for cardiorespiratory effort but also for muscle fatigue. The exerciser may use the scale to rate the overall feeling of exertion. The appropriate range is between the ratings of 4 (Somewhat Heavy) and 7 (Very Heavy), which is equivalent to 65-80 percent VO_2 max.

Exhibit 13. Rating of Perceived Exertion Scale (RPE)

0	Nothing at all
0.5	Extremely Light (just noticeable)
1	Very Light
2	Light (weak)
3	Moderate
4	Somewhat Heavy
5	Heavy (strong)
6	
7	Very Heavy
8	
9	
10	Extremely Heavy (almost max)
●	MAXIMAL

The RPE scale is used to relate how you feel when exercising aerobically. The shaded area represents the aerobic training window (i.e., between 65 and 80% of VO_2max). Scale was developed by and is the courtesy of Dr. G. Borg, Department of Psychology, University of Stockholm, Sweden.

Many activities are popular for improving aerobic capacity. For optimal benefits they should be done within the proper zone of intensity three to six times per week for durations ranging from 20 minutes to an hour. Running or jogging (at the rate of 12 minutes per mile or faster) is perhaps the most efficient for improving aerobic capacity and burning calories. During inclement weather the treadmill can be used for running or for another popular mode -- walking. Walking is particularly appropriate for people of low fitness. Because walking consumes about 25 percent fewer calories per mile than jogging, the duration of the workout has to be lengthened to get a similar benefit. For example, a person running at 10-minutes per mile will consume about 300 to 350 kilocalories in 30 minutes. To get an equal caloric effect, the walker, moving at 15-minutes per mile, will have to continue for a full hour.

The workload on a stationary bike can be adjusted to an appropriately vigorous intensity. Outdoor biking is a different story. Traffic conditions in the city make it very difficult to maintain an appropriate average intensity on a bicycle; therefore, the ride may have to last up to 90 minutes.

Swimming is another popular aerobic training mode with limitations similar to walking and biking. Research on swimming programs reveals a very poor fat-loss record. The problem may be a combination of the cooling properties of the water, less stressful horizontal position, and smaller muscles used as prime movers (i.e., the arms). For this reason, weight loss programs in the water may require at least 45 minutes per session.

The stair climber has become the most popular apparatus in the exercise club. The potential of this machine for aerobic training and weight control is seldom attained. Users tend to hold onto the rails, reducing much of the cardiovascular strain. Also, many users lean on the rails, extending their rumps, which alters the biomechanics of the activity so as to actually increase hip size by muscle hypertrophy -- the opposite goal for most exercisers.

Aerobic dancing is a very popular mode with great potential. However, research on weight loss by this means has given the activity very poor marks. The problem appears to be in the number of sessions per week and the duration of the aerobic activity phase. Most classes are scheduled to meet three days per week for an hour. After all of the stretching and strengthening activities, per class the aerobic training normally

averages no more than 20 minutes. The lesson for aerobic dancers is to select an instructor who will keep the class moving aerobically for at least 30 minutes and to attend the class three or four times each week.

The image of the ideal physique is thin, thin, thin. Fatness standards are too often influenced by Hollywood and Madison Avenue, which promotes a body image closer to emaciation than health. Guilt for overemphasizing leanness might be shared by the fitness industry. For example, a number of fitness textbooks and manuals encourage a body fat range for women between 15 percent and 26 percent. In view of the potential for error when measuring body fat (about 3.5 percent for the skin-fold method), a woman measured at 15 percent could be dangerously close to under-fatness, and there is no scientific or medical evidence of increased disease risk at 26 percent. As a general guide, the acceptable range of relative fat for men is between 10 percent and 22 percent; the range for women is between 18 percent and 32 percent. The standard for a man is about 15 percent and about 25 percent for a woman (see Exhibit 14). These are health standards. Athletes and movie stars may have leaner standards.

Exhibit 14. Relative Fatness

	Men	Women
Essential	3-5%	11-13%
Standard	15%	25%
Over-fat	20%	30%
Obese	25%	35%
Acceptable Range	10-22%	18-32%
Under-fat	3-7%	10-18%

People lose weight by expending excess calories in exercise, eating fewer calories than needed for current weight, or by a combination. Several years ago, a woman weighing 140 pounds with 35 percent fat came to the JSC Health-Related Fitness Office. Her goal was to lose 19 pounds. Her 20-year high school reunion was three months

away and she wanted to weigh the same as she had on the day of her graduation. She hoped to lose the weight by exercise alone -- with no dieting. She was capable of jogging 90 minutes per week (which is pretty good). We calculated that it would take 1.54 years for her to exercise away the 66,500 kilocalories contained in her excess 19 pounds (see Exhibit 15).

Exhibit 15. Weight Loss Through Exercise -- No Dieting

Scenario: 140 lb woman, 35% fat, needs to lose 19 lbs to reach her desired level of 25% fat	3500 Kcals/lb of fat x 19 lbs fat 66,500 Kcals must be expended in exercise
Jogging a 12-minute mile: burns 9.19 Kcals/minute	63.64 kg x 8.66 METS / 60 kg = 9.19 Kcal/minute
burns 276 Kcals in 30 minutes	9.19 Kcal/min x 30 = 276 Kcals
burns 828 Kcals/week at 3x/week	276 Kcals x 3 = 828 Kcals
Weight loss = 19 lbs in 1.54 years	66,500 Kcals / 828 Kcal/week = 80.31 weeks = 1.54 years

Since the reunion was only three months away, the exercise-only option was not acceptable. She decided to go on a crash diet. With 1,124 kilocalories per day, she lost the 19 pounds in three months. An assessment of her body composition revealed that she dropped from 35 percent fat to 27 percent fat, but the weight she lost was not all in the form of fat tissue. She lost 16 pounds of fat and 3 pounds of muscle (see Exhibit 16).

Exhibit 16. Weight Loss Through Dieting Only

1124 Kcal/day diet for 12 weeks to lose 19 lbs				
	Weight (lbs)	%Fat	Fat Weight (lbs)	Lean Weight (lbs)
Pre	140	35	49	91
Post	121	27	33	88
Change	-19	-8	-16	-3
Quits diet and 12 weeks later...				
	140	37	52	88
Change	+19	+10	+19	0

- Resulting Condition
  - muscle is lost in crash dieting
  - creeping obesity
  - reduction in strength

Metabolizing muscle tissue for energy is a common result of excessive caloric restriction. On the day of the reunion this woman began to put the weight back on, and 12 weeks later, 24 weeks after starting her diet, she returned to our program again weighing 140 pounds. But in terms of relative weight she was no longer the same person. She was like the man who at age 55 bragged of weighing the same as at age 20, but whose waist size had grown from 31 to 38 -- his chest fell. An assessment of body composition showed her relative fatness had risen to 37 percent (2 percent above the original). All of the weight gain had been in the form of fat. Because she had not exercised, she did not regain the lost muscle tissue. She failed to recognize that muscle weight cannot be gained by eating muscle; increasing muscle requires exercise. The overall result of her crash diet was that it made her fatter (37 percent versus 35 percent) and weaker (less muscle means less strength). Finally, she went on a combination program of exercise (jogging about 90 minutes per week) and dieting on a moderately restricted 1,500 kilocalories per day (note the previous diet had been 1,100 kilocalories per day). In 12 weeks she lost 19 pounds and dropped to 25 percent fat (see Exhibit 17). Interestingly, she lost 22 pounds of fat and regained the 3 pounds of muscle.

Exhibit 17. Weight Loss Through Exercise -- Plus Dieting

For 140 lb woman to lose 19 lbs in 12 weeks requires:
90 min/week jogging (12-minute mile)
1500 kcal/day diet

	Weight (lbs)	% Fat	Fat Weight (lbs)	Lean Weight (lbs)
Pre	140	37	52	88
Post	121	25	30	91
Change	-19	-12	22	+3

Muscle strength and muscle endurance are ordinarily more a concern for athletics than for health. Success in American sports is almost always related to the power and speed accrued from strength. However, the capacity to bench-press 300 pounds has no relation whatever to functional health. Nevertheless, many health conscious participants need some strength training, particularly for the upper body, because they commonly

become leg athletes. That is, they build up their legs by running or biking, but become derelict in the upper body from disuse. Weight-lifting is the most efficient means for improving strength. Many programs are effective. The workout plan should include a rest period of about a day following a vigorous bout. Maximal gains in strength have been reported on programs of three days per week, although similar though slightly lower gains were reported in twice-weekly programs. Abdominal muscles deserve special attention because weak abdominals increase the potential for back injuries. The bent-knee curl-up with the feet unsupported is the recommended calisthenic. Bending the knees removes the tendency to arch the back (a potential for injury), and keeping the feet unanchored places all the work responsibility on the abdominals. When the feet are anchored most of the effort is transferred from the abdominals to the thighs.

Exercise programs, especially those practiced to excess, bring some risk of musculoskeletal injury. One way to lower the probability of straining or tearing muscles and connective tissues is to retain their suppleness and pliability. This is done by stretching. Perhaps the easiest and most convenient technique is to gently stretch the muscle and hold the stretch statically at the point of tension for about 30 seconds.

For optimal improvements in cardiorespiratory endurance and body composition, aerobic exercises should be performed at about 70 percent of maximal capacity. The minimum frequency for aerobic conditioning is three days per week, but appreciable fat loss is not achieved unless the program is done at least four days per week. For increasing aerobic capacity the workouts should start at about 15 minutes to prevent injuries and progress to 45 or 60 minutes. The minimum duration for fat loss is 30 minutes and, depending on the intensity, the duration might even exceed an hour. It is important to appreciate that the often-quoted prescription of 20 minutes of aerobic exercise three days per week is the *minimum* for a beginner. Fitness will not progress unless the program progresses.

A well-rounded program also includes some weight training done two to three days per week for 30 to 45 minutes. A manageable program for the beginner involves jogging Monday, Wednesday, and Friday, and lifting weights Tuesday and Thursday. To maintain flexibility and reduce the chance of musculoskeletal injuries, a daily stretching routine should be followed. At a minimum the exercised muscles should be stretched for about 30 seconds following an aerobic workout. Exhibit 18 is a chart of recommended physical exercise.

Exhibit 18. Recommended Physical Exercise

Fitness Component	Exercise Type	Intensity	Frequency (times/wk)	Duration
Cardiorespiratory Endurance	Aerobic	50-85% VO_2max	3 - 5	15-60 Min.
Body Composition	Aerobic	50-85% VO_2max	4+	30-60 Min.
Muscular Strength	Weight-Lifting and Timed Calisthenics	60-80% 1RM	2 - 3	30-45 Min.
Flexibility	Static Stretching	Tension	Daily	30 Sec. Ea.

Exercise is really not complicated. The key is doing it. We published an evaluation of the Employee Wellness Program at JSC in *Aviation, Space and Environmental Medicine*.[11] The evaluation showed the program was indeed effective for improving fitness and health, but only for those who followed the program. The benefits of exercise come only to those who exercise.

Healthy People 2000 has given us the mission of getting more Americans to exercise at a level that is beneficial for health. In our efforts to persuade the sedentary population to take action we should not make the mistake of saying that exercise is easy. Sometimes exercise is downright hard. Developing the habit of exercising persistently over the weeks and months and years is certainly not easy. It is not easy for sedentary people to develop an exercise practice into a lifetime habit. Getting everyone to do it -- now that is hard.

References

1. U.S. Department of and Human Services. *Healthy People 2000: National Promotion and Disease Prevention Objectives*. U.S. Government Printing Office, Washington, D.C., 1990.

2. Wier, L.T., & Jackson, A.S. Factors Affecting Compliance in the NASA/Johnson Space Center Fitness Program. *Sports Medicine*, 8:9-14, 1989.

3. Paffenbarger, R.S. Jr., Hyde, R.T., Wing, A.L., & Hsieh, C-C. Physical Activity, All-Cause Mortality, and Longevity of College Alumni. *New England Journal of Medicine*, 314:605-613, 1986.

4. Frisch, R.E.; Wysha, G., Albright, V.L., et al. Lower Prevalence of Breast Cancer and Cancers of the Reproductive System Among Former College Athletes Compared to Nonathletes. *Br. J. Cancer*, 52: 885-91, 1985.

5. Wier, L.T., Jackson, A.S., & Pinkerton, M.B. Effects of Body Composition and VO_2max on HDL-C: Cross-Sectional and Longitudinal Analyses. *Medicine and Science in Sports and Exercise*, 23 (supplement):S50, 1991.

6. Jackson, A.S., Beard, E.F., Wier, L.T., Ross, R.M., Stuteville, J.E., & Blair, S.N. Changes in Physical Fitness Over Time: The Influence of Exercise, Body Composition, and Age. *JAMA* (in press), 1993.

7. Wier, L.T., Jackson, A.S., Ayers, G.W., & Stuteville, J.E. The Role of Body Composition and Physical Activity on the Age-Related Decline in VO_2max in Women (Ages 21-63). *Medicine and Science in Sports and Exercise* (Pending), 1993.

8. American College of Sports Medicine. The Recommended Quantity and Quality of Exercise for Developing and Maintaining Cardiorespiratory and Muscular Fitness in Healthy Adults. *Medicine and Science in Sports and Exercise*, 22:265-274, 1990.

9. Wier, L.T., & Jackson, A.S. %VO_2max and %HRmax Reserve Are Not Equal Methods of Assessing Exercise Intensity. Medicine and Science in Sports and Exercise, 24 (supplement):S176, 1992.

10. Noble, B.J., Borg, G.A.V., Jacobs, I., Ceci, R., Kaiser, P.A., & Nordgren, B. A Category-Ratio Perceived Exertion Scale: Relationship to Blood and Muscle Lactates and Heart Rate. *Medicine and Science in Sports and Exercise*, 15:523-528, 1983.

11. Wier, L.T., Jackson, A.S., & Pinkerton, M.B. Evaluation of the NASA/JSC Health-Related Fitness Program. *Aviation, Space and Environmental Medicine*, 60:438-444, 1989.