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Exercise Prescription for Health

Steven N. Blair

Many exercise scientists describe physical activity programs as either exercise for health or exercise for fitness. Data on the dose-response gradient for the relation of physical activity or physical fitness to health and function are reviewed herein to examine this hypothesis. This conceptualization is refuted in this paper. Moderate amounts and moderate intensities of activity or fitness are associated with improved clinical status, higher levels of physical fitness, and lower risk of mortality. This leads to the conclusion that the single most important component of a physical activity regimen is total energy expenditure, whether the desired outcome is health or physical activity. If this view is correct and total energy expenditure should be the primary focus, additional flexibility in physical activity recommendations is possible. Both traditional formal exercise programs and lifestyle physical activity can make important contributions to health and function.

Ancient scholars and physicians knew that physical activity was an important health habit, and physical educators in the 19th century examined the relation of exercise to health. Modern scientific investigations of this issue began in earnest in the 1950s with the pioneering work of Karvonen, Kentala, and Mustala (1957) on exercise prescription and Morris and Crawford (1958) on epidemiological studies of activity and coronary heart disease.

Karvonen et al.'s (1957) work inspired many investigators to examine the frequency, intensity, and duration components of an exercise program, and the formal exercise prescription methods codified by the American College of Sports Medicine (ACSM, 1978) emerged from this body of knowledge. Dr. Michael Pollock was one of the leaders of this line of research, and he provides an excellent summary of current knowledge about exercise prescription for physical fitness in the previous article (Pollock, Feigenbaum, & Brechue, 1995).

Professors Jeremy Morris (Morris, Clayton, Everitt, Semmence, & Burgess, 1990; Morris, Pollard, Everitt, & Chave, 1980) and Ralph Paffenbarger (Paffenbarger, Hyde, Wing, & Hsieh, 1986; Paffenbarger et al., 1993; Paffenbarger, Wing, & Hyde, 1978) were the leaders in conducting research on physical activity and health. Most of the studies, until recently, focused on cardiovascular disease, and this evidence is summarized in this issue by Arthur Leon (Leon & Norstrom, 1995), who

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also made important contributions to this research effort (Leon, Connett, Jacobs, & Rauramaa, 1987).

Although there are similarities between the studies on exercise and fitness and physical activity and health, there also are important differences. First, the exercise and fitness studies were mostly experimental investigations, and many were randomized clinical trials. This research paradigm allows for careful quantification and control of the experimental variable, in this case dose of exercise. In contrast, the epidemiological studies were observational studies in which physical activity was measured by self-report of habitual activity patterns. These questionnaires typically yielded numerical estimates of amount of physical activity, but they were inevitably relatively crude and imprecise. In addition, the epidemiological studies did not allow for careful control of the exposure variable.

A second obvious major difference between experimental and epidemiological studies was the primary dependent variable. Experimental studies used a measure of physical fitness, usually maximal oxygen uptake, and epidemiological studies focused on morbidity and mortality rates.

Exercise training studies are usually short term. Many early studies were 10 weeks in length, and some studies of only 4–6 weeks are reported in the literature (Burke & Franks, 1975; Faria, 1970; Sharkey, 1970). Only in more recent times are studies of 6 months or one year commonly available (King, Haskell, Taylor, Kraemer, & DeBusk, 1991; Wood et al., 1983; Wood, Stefanick, Williams, & Haskell, 1991). Even today, there are very few studies of longer than one year. This feature of experimental studies may influence conclusions drawn from the data. For example, it is entirely possible, and in fact was demonstrated in some studies, that a specific exercise dose might not improve fitness over the short term, but would have an impact over a longer training period. The prospective epidemiological studies extend over several years. The physical activity exposure measured at baseline was usually an estimate of habitual activity level. Some of the questionnaires used actually asked for activity over the past year (Leon et al., 1987), and many others undoubtedly obtained self-reports of activity that study participants averaged over an extended period (Helmrick, Ragland, & Leung, 1991; Kaplan, Seeman, & Cohen, 1987; Lee & Paffenbarger, 1992; Paffenbarger et al., 1986).

Finally, investigators in these two research areas usually came from different biomedical research areas, with differences in methods and ways of approaching research questions. Physiologists who use the experimental method tend to contrast various discrete treatments. For example, specific levels of intensity, frequency, and duration can be experimentally controlled with precision. Epidemiologists frequently evaluate data with the exposure expressed as a continuous variable. This leads to looking for trends or dose–response gradients in the relation between independent and dependent variables. I believe that these factors led experimentalists to focus on an exercise threshold necessary to produce a significant increase in VO_2max. This led, in turn, to a specific and quantified exercise prescription that helped create the impression that unless one achieved or exceeded the prescribed dose, no improvements in fitness could be expected. These studies influenced health professionals and the public to view exercise as an either-or phenomenon. That is, a person is either active or sedentary.

Several reports in recent years emphasize the dose–response gradient for physical activity or physical fitness and various health outcomes (Blair, 1993; Blair, Kohl, Gordon, & Paffenbarger, 1992; Helmrick et al., 1991; Paffenbarger et al., 1986). As this concept gained acceptance, and as comparisons were made with the traditional exercise prescription, the concept of exercise for fitness or for health surfaced (Duncan, Gordon, & Scott, 1991). I am not very enthusiastic about this approach. I think the relation between exercise or physical activity and either fitness or health is a graded response. Individuals who do a little activity are both more fit and more healthy than those who do none. Persons who are highly active are more fit and more healthy than the moderately active. I think that the single most important aspect of the exercise program is the total energy expenditure resulting from the activity. An energy expenditure of 1,200 kJ $\cdot$ day^{-1} is likely to have comparable effects on increases in fitness and health status (Blair et al., 1992; Haskell et al., 1994) with little differential impact for various patterns of frequency, intensity, or duration. Therefore, I do not believe that we should view exercise prescription as falling into either the fitness or health category. My view does have public health implications. If this perspective is correct, there is much more freedom to design activity programs and help sedentary individuals discover what works for them.

The hypothesis that total energy expenditure (and not specific combinations of frequency, intensity, and duration) is of greatest importance needs further evaluation. I do not consider the issue closed, and I certainly encourage more research on the question. However, there is enough evidence supporting the hypothesis, and enough reasons for using this approach to plan programs, that we can take action on the concept while additional research is being conducted. The remainder of this report is devoted to summarizing the evidence supporting the total energy expenditure hypothesis and discussing the public health applications of this concept.

Physical Activity and Fitness Dose–Response Gradient

Emphasis on the traditional approach to exercise prescription, with a focus on specific frequency, intensity, and duration of activity, obscures the dose–response gradient of physical fitness or health across the spectrum of energy expenditure. Recent reexaminations of the fundamental tenets of the traditional exercise prescription lead to an appreciation of the impact of moderate amounts and moderate intensities of activity on fitness and health. A summary of the evidence relating to these two points is presented in the following sections.

Moderate Amounts of Physical Activity

There is considerable evidence in the literature for a dose–response gradient across different levels of total energy expenditure for physical fitness and various measures of health (Blair et al., 1992; Haskell et al., 1994). Studies are available from both the experimental and epidemiological literature and for fitness and health status endpoints.

Dose–Response Studies of Risk Factors. Cross-sectional and longitudinal studies show a strong inverse association between various clinical and behavioral risk factors and physical activity. Several of these reports include more than two physical activity categories, which allows for evaluation of a dose–response gradient. Earlier studies included only men, but more recent investigations include men and women. The study groups are from employed populations or other opportunistic samples (Hickey, Mulcahy, Bourke, Graham, & Wilson-Davis, 1975) and are representative population samples (Bauman & Owen, 1991; Department of the Arts, Sports, The Environment and Territories, 1992; MacAuley et al., 1994; Sports Council and Health Education Authority, 1992; Tuomilehto et al., 1987). There is great consistency across these reports. Participants who reported more physical activity typically had higher levels of physical fitness and more favorable coronary heart disease (CHD) risk factor distributions than did those who were sedentary. The results are similar across the adult years. Some of the studies adjusted for potential confounding variables such as body composition, alcohol intake, and smoking, and the inverse gradient for risk factors across activity levels remained the same as for the unadjusted analyses.

Although most of the work on physical activity and clinical variables examined CHD risk factors, other important measures are also related to regular activity. For example, Krall and Dawson-Hughes (1994) evaluated the association of distance walked to bone mineral density. They studied 239 healthy, white, postmenopausal women (ages 43 to 72 years). Study participants completed a questionnaire about the weekly distance walked during the previous month, and had their bone mineral densities assessed by dual-energy absorptiometry. Distance walked was classified by quartiles, with the lowest quartile of women walking less than one mile per week and the highest quartile walking at least 7.5 miles per week. There was a significant ($p < .01$) direct trend across walking quartiles for whole body, trunk, and leg bone mineral densities. These trends persisted over a 1-year follow-up interval. These data show that even quite moderate amounts of walking, the top quartile after all walked only a little more than one mile a day, are associated with some measures of health.

Controlled experiments confirm these population-based study results. One of the best examples is from a study by Wood et al. (1983). They randomly assigned 81 initially sedentary men aged 30 to 55 years to either an exercise or control group in order to examine the impact of exercise on the lipoprotein profile. The study was carefully controlled, and the men exercised for one year by walking/jogging under supervision. The researchers compared miles run per week to changes in various blood lipids and lipoproteins. Four categories of running were 0–3.9, 4.0–7.9, 8.0–12.9, and >13.0 miles per week. There was a strong trend across these categories for favorable changes in most lipids and lipoproteins and for body composition. Those who ran the most had the greatest changes, but men in the second and third weekly running categories made more improvement than men in the bottom group.

Dose–Response Studies of Mortality. Most of the recent studies of either physical activity or physical fitness in relation to mortality risk include multiple categories of these variables (Blair et al., 1989; Ekelund et al., 1988; Hickey et al., 1975; Leon et al., 1987; Morris et al., 1990; Paffenbarger et al., 1986; Paffenbarger et al., 1993; Paffenbarger, Lee, & Leung, 1994; Shaper & Wannamethee, 1991; Wannamethee & Shaper, 1992). In nearly every case, a dose–response gradient was evident, and this association was seen for several endpoints, including all-cause and cause-specific mortality, hypertension, and clinical depression. An example of such a gradient is presented in Figure 1, which is based on data from the British Regional Heart Study (Wannamethee & Shaper, 1992). Men (N = 7,735) aged 40–59 years from general practices in several towns in the United Kingdom were followed for 9.5 years after a baseline examination. Physical activity was measured at this initial examination by self-report questionnaire. The steep downward slope of stroke risk across activity categories clearly illustrates the benefit of even light amounts of

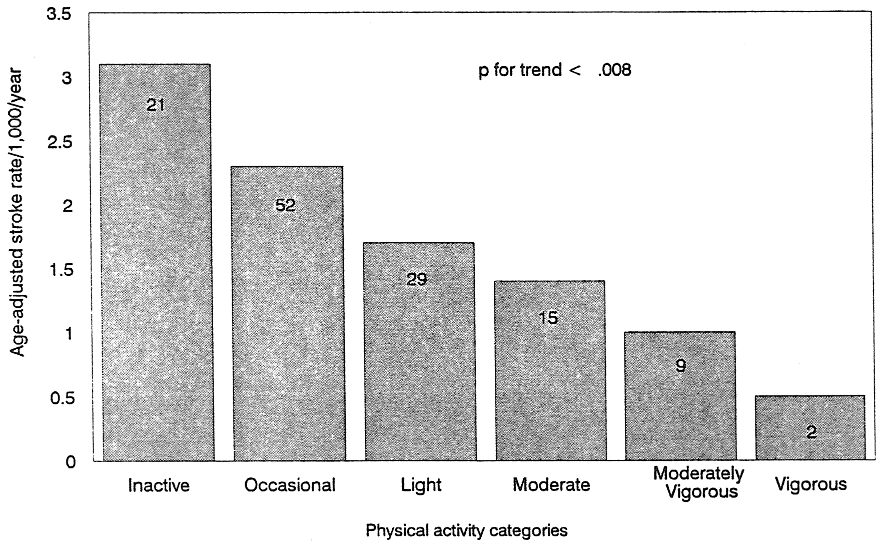

Figure 1 — Age-adjusted stroke rate by physical activity categories in the British Regional Heart Study. Participants were 7,735 men aged 40–59 years at baseline who were followed for 9.5 years, during which time 128 strokes occurred. Data from Wannamethee and Shaper (1992). *Note.* From "1993 C.H. McCloy Research Lecture: Physical Activity, Physical Fitness, and Health," by S.N. Blair, 1993, *Research Quarterly for Exercise and Sport, 64*, p. 367. Copyright 1993 by the American Alliance for Health, Physical Education, Recreation and Dance. Reprinted with permission.

physical activity. Similar trends are noted in other reports for other disease endpoints and for all-cause mortality.

Preliminary analyses on physical fitness and mortality from our continuing follow-up in the Aerobics Center Longitudinal Study are consistent with the physical activity studies briefly reviewed above. Earlier studies in this cohort demonstrated a strong protective effect from moderate levels of physical fitness (Blair et al., 1989; Kohl, Gordon, Villegas, & Blair, 1992). We now have 7,342 women and 26,387 men who were examined at the Cooper Clinic at least once during 1970–1989. They have been followed for mortality through December 31, 1989, during which time 116 women and 824 men died. All study participants completed a maximal exercise test on a treadmill at their baseline examination. Physical fitness categories for these analyses are based on maximal time on the treadmill test. Low fitness refers to the least fit 20% of the men and women in each age group. Moderate fitness is defined here as the next 40% of the fitness distribution, with the top 40% constituting the high-fitness group. Due to the smaller number of deaths in the women, we usually collapse the moderate and high fitness categories in their analyses. Age-adjusted all-cause and cardiovascular disease death rates by fitness categories are shown in Figures 2 and 3 for women and men, respectively. It is clear from these data that there is a substantially reduced mortality risk for the moderately fit individuals. Extensive multivariate modeling analyses to control for potentially confounding variables such as body composition, health status, and other CHD risk factors failed to eliminate the strong effect of fitness on mortality.

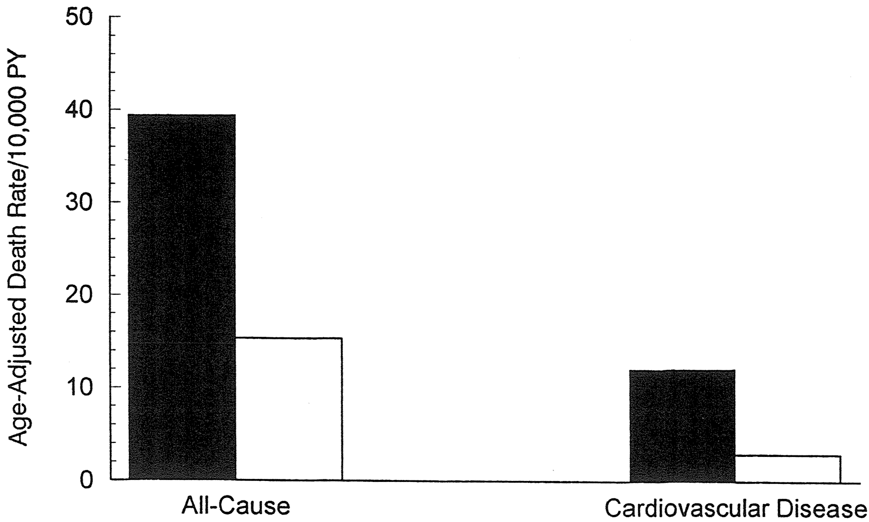

Figure 2 — Age-adjusted all-cause and cardiovascular disease mortality rates per 10,000 person-years of follow-up in 7,342 women in the Aerobics Center Longitudinal Study. Black bars show the age-adjusted death rates for the low physical fitness group (least fit 20%), and white bars show death rates for the fit women (all others). There were 116 deaths (27 from cardiovascular disease) over an average follow-up interval of approximately 8 years, with a total follow-up of 54,956 person-years of observation.

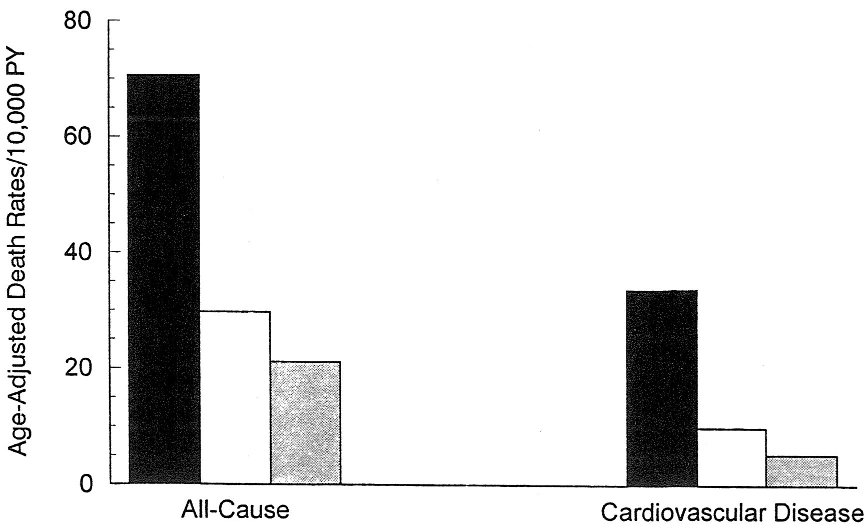

Figure 3 — Age-adjusted all-cause and cardiovascular disease mortality rates per 10,000 person-years of follow-up in 26,387 men in the Aerobics Center Longitudinal Study. Black bars show the age-adjusted death rates for the low physical fitness group (least fit 20%), white bars the moderately fit group (the next 40% of the fitness distribution), and the stippled bars the high fit group (the most fit 40%). There were 824 deaths (312 from cardiovascular disease) over an average follow-up interval of approximately 8 years, with a total follow-up of 220,004 person-years of observation.

The reduced risk of mortality in the more fit men and women is evident throughout the age range. We examined the relation between fitness and mortality in the subgroup of study participants aged 50 years and older (Bokovoy & Blair, 1994). There were 2,054 women (77 deaths) and 6,878 men (513 deaths) available for these analyses. The gradient of mortality risk across fitness categories was virtually identical to the overall analyses described above. There were enough deaths in the men to perform the analyses in 5-year age groups (Figures 4 and 5). The relation of fitness to mortality is quite similar for both all-cause and cardiovascular disease mortality in all age groups. Note the substantial reduction in risk even in the men ≥70 years of age. It appears that it is never too late to benefit from being fit.

Changes in Activity or Fitness and Mortality. Although the data reviewed here on the association of low levels of activity or fitness to increased mortality risk are compelling, they do not answer the question of whether there would be a benefit for sedentary or unfit people who improve on these characteristics. It is possible that confounding variables, such as genetic factors, might cause both low activity or fitness and increase the risk of dying. Exciting new data published in the past 2 years provide additional support for the low activity–increased risk of disease hypothesis. Two reports (Blair, 1993; Paffenbarger et al., 1993) show that initially sedentary men who begin to do at least a moderate amount of exercise have a substantial reduction in mortality risk. In both of these studies, starting to exercise had a similar impact on mortality reduction as did stopping smoking.

We also examined this issue by looking at changes in physical fitness in 9,777 men who had at least two examinations at the Cooper Clinic over the period

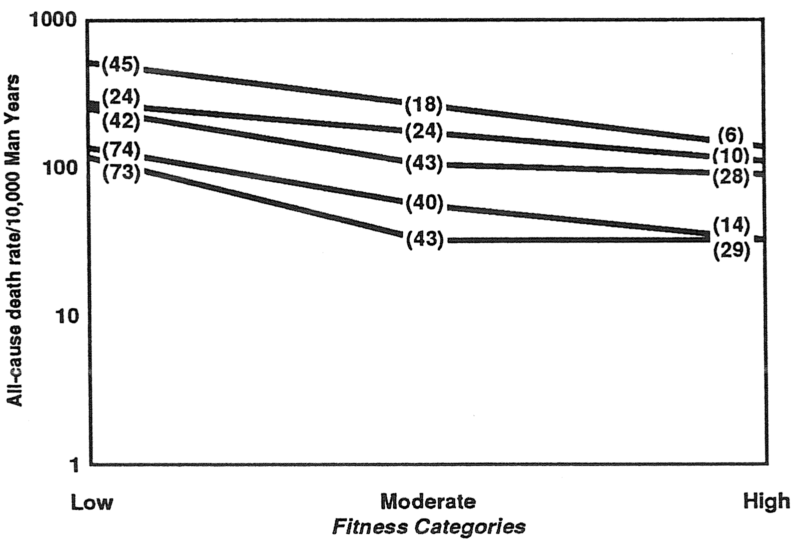

Figure 4 — All-cause death rates for 5-year age groups across physical fitness categories in 6,878 men 50 years of age and older in the Aerobics Center Longitudinal Study. Numbers in parentheses are the number of deaths in the specific group. *Note.* From "Aging and Exercise: A Health Perspective," by J.L. Bokovoy and S.N. Blair, 1994, *Journal of Aging and Physical Activity, 2,* p. 255. Copyright 1994 by Human Kinetics. Reprinted with permission.

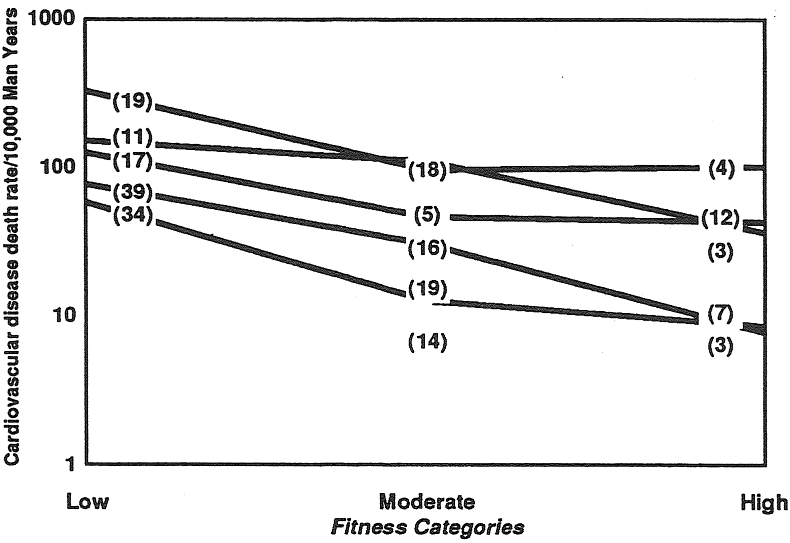

Figure 5 — Cardiovascular disease death rates for 5-year age groups across physical fitness categories in 6,581 men 50 years and older in the Aerobics Center Longitudinal Study. Numbers in parentheses are the number of deaths in the specific group. *Note.* From "Aging and Exercise: A Health Perspective," by J.L. Bokovoy and S.N. Blair, 1994, *Journal of Aging and Physical Activity, 2*, p. 255. Copyright 1994 by Human Kinetics. Reprinted with permission.

1970–1989 (Blair et al., 1995). The average interval between the first and last examination was approximately 5 years, with 5 more years of mortality follow-up after the subsequent examination. There were 223 deaths during the nearly 50,000 man-years of follow-up. Age-adjusted all-cause and cardiovascular disease death rates for men who were unfit at both examinations and for men who improved from unfit at the first to at least moderately fit at the second examination are shown in Figure 6. Men who improved their fitness had a reduction in risk of dying of about 50% when compared with their peers who stayed unfit. Furthermore, the degree of risk reduction was related to the amount of change in physical fitness. In proportional hazards regression analyses with control for age, health status, body composition, and other risk factors, each minute improvement in treadmill time from the first to the subsequent examination was associated with approximately a 9% reduction in mortality. Improvement in fitness in this study resulted in a greater reduction in mortality risk than presumably beneficial changes in body composition, cholesterol, and blood pressure, and had a comparable reduction on mortality to stopping smoking.

Summary. I believe it is reasonable to conclude that there is a dose–response gradient across physical activity and physical fitness categories for several important clinical variables such as blood pressure, fasting glucose, blood lipids, and body composition. This hypothesis is supported by cross-sectional and longitudinal population-based studies, and by controlled experiments. Men and women who get moderate amounts of physical activity appear to receive health benefits in comparison to less active and more unfit individuals. Furthermore, persons who participate in

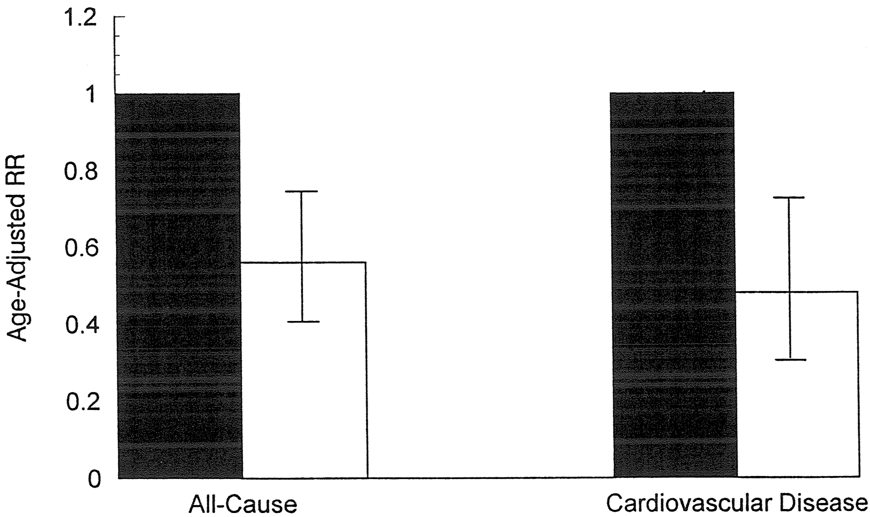

Figure 6 — Age-adjusted relative risk (RR) of death from all-cause and cardiovascular disease mortality in 9,777 men in the Aerobics Center Longitudinal Study. Black bars are the reference category and represent the risk of death in men who were in the low-fitness category (least fit 20%) at their first and subsequent examinations. White bars show the reduction in risk of dying during follow-up in men who improved to be at least moderately fit by the subsequent examination. There were 223 deaths (87 from cardiovascular disease) during 47,560 person-years of follow-up. Data from Blair et al. (1995).

high levels of activity generally have more favorable risk factor profiles than those in the moderate category.

The benefit of moderate amounts of activity or fitness also is apparent from the mortality studies. In addition, several reports show even greater risk reduction in the high active and fit groups. Recent findings on the benefits of converting from sedentary and unfit status to active and fit strengthen the hypothesis that physical activity prevents disease and delays mortality. All these findings lead to the conclusion that ''some activity is better than none.''

Moderate Intensities of Physical Activity

There has been much attention given to the importance of exercise intensity by exercise scientists. Considerable effort over the past 40 years was directed to defining a minimal exercise intensity required to produce change in physical fitness, usually measured by VO_2max. The generally accepted recommended exercise intensity changed from 70% in the mid-1970s to 40% today, according to the ACSM book on exercise guidelines I have discussed earlier (Blair et al., 1992). This major change in expert opinion makes me question whether we know even today if there is a minimum exercise intensity or, if there is, its precise definition. Epidemiologists also showed an interest in intensity issues, with Morris and colleagues (Morris et al., 1990; Morris et al., 1980) the principal researchers recommending a minimum intensity threshold.

Clinical Studies on Exercise Intensity. Emphasis on the intensity of exercise was noted by Karvonen et al. (1957). They had young male medical students train at a moderate intensity (n = 3; 60% of their maximal heart rate range) or a high intensity (n = 4; ranging from 71 to 75% of their maximal heart rate range). The students ran for 30 min per day for 4 or 5 days a week over a 4-week training period. Note that because each subject ran for 30 min, those who trained at a higher intensity actually ran farther than those who trained at the moderate intensity. Each run was at their prescribed intensity as defined by their percent maximal heart rate range. The principal outcome measure in this study was the speed they could sustain at their prescribed training heart rate. One of the 3 who trained at a moderate intensity increased running speed, and all 4 who trained at the higher intensity increased their running speed. Two of the 3 who trained at a moderate intensity and all 4 who trained at a higher intensity had lower maximal heart rates at the end of the study, and all students had reduced their resting heart rates.

The results of Karvonen et al.'s (1957) study were widely interpreted for many years as indicating that a training heart rate of 70% or more is required to produce changes in aerobic power. I think that this overstates the findings. There was evidence that some changes in the cardiovascular system occurred in the students who trained at a lower intensity. When we also consider that the students training at the higher intensity ran more miles and that the study was of short duration, the sanctity of the 70% intensity criterion becomes somewhat more suspect.

I do not mean to diminish the importance of this landmark paper. Professor Karvonen was a pioneer, and we are indebted to his work. This study was perhaps the first controlled experiment to attempt to specify the exercise dose necessary for change in fitness. An example of how this study influenced exercise scientists thinking is evident from a review of studies over the 20 years after the Karvonen et al. (1957) report. Several investigators examined various components of the exercise prescription, including the role of intensity in controlled studies (Burke & Franks, 1975; Faria, 1970; Sharkey, 1970; Sharkey & Holleman, 1967; Shephard, 1968). These studies had features in common. All used young men (high school or college age) as participants, training periods were typically less than 10 weeks, and exercise intensity ranges used were from 39 to 96% of maximal capacity. Even in these short-term studies of healthy young men, the low-intensity training groups made improvements in fitness, usually measured by VO_2max. However, the higher intensity training groups frequently made greater improvement than the lower intensity groups, which caused exercise scientists to continue to discount the benefit of moderate intensity physical activity. I think that a more correct conclusion from these, and other more recent studies on intensity (Duncan et al., 1991; Foster, Hume, Byrnes, Dickinson, & Chatfield, 1989; Gaesser & Rich, 1984; Gossard, Haskell, & Taylor, 1986; King et al., 1991), is that physical fitness can be improved by exercise training at intensities of 40% (or perhaps even less) of maximal capacity; however, the changes may not occur as rapidly, and may not be as great, as when high intensity training is done.

Epidemiological Studies on Intensity. Few epidemiological studies on physical activity and health have adequate data to evaluate the importance of exercise intensity. Morris et al. (1990) continue to report that vigorous exercise is required to protect against heart attacks. Their definition of vigorous exercise is that which requires an energy expenditure of 7.5 kcal per minute. For the average weight man in their British Civil Servants Study, this amounts to activities requiring an intensity of approximately 5 METs (or five times the resting energy expenditure). This rate can be achieved by brisk walking (for example at a speed of about 4.5 mph). Paffenbarger et al. (1993) report that moderately vigorous sports play, which they define as requiring an energy expenditure of ≥4.5 METs, is associated with substantial reduction in mortality risk and extended longevity. This Harvard Alumni Study data also support a reduction in risk associated with more moderate intensities of physical activity.

There also is ample evidence supporting the hypothesis that moderate intensity physical activity is related to reduced risk of cardiovascular disease and all-cause mortality. Numerous studies (see Blair, 1994, for a review) show higher death rates in sedentary individuals when compared with persons who get at least some activity. Physical activity assessment methods in most of these studies were not sufficiently precise to specifically evaluate exercise intensity, but the questionnaires tended to focus on lifestyle activities or activity required on the job, which in both cases is typically of no more than moderate intensity. Furthermore, our data from the Aerobics Center Longitudinal Study (Figure 7) show that converting from no physical activity to at least some activity is associated with an approximate 50% reduction in all-cause mortality, an amount that is comparable to other beneficial risk factor changes (Blair, 1993).

I believe that current data support the hypothesis that moderate intensity exercise reduces the risk of morbidity and mortality. Additional research is needed

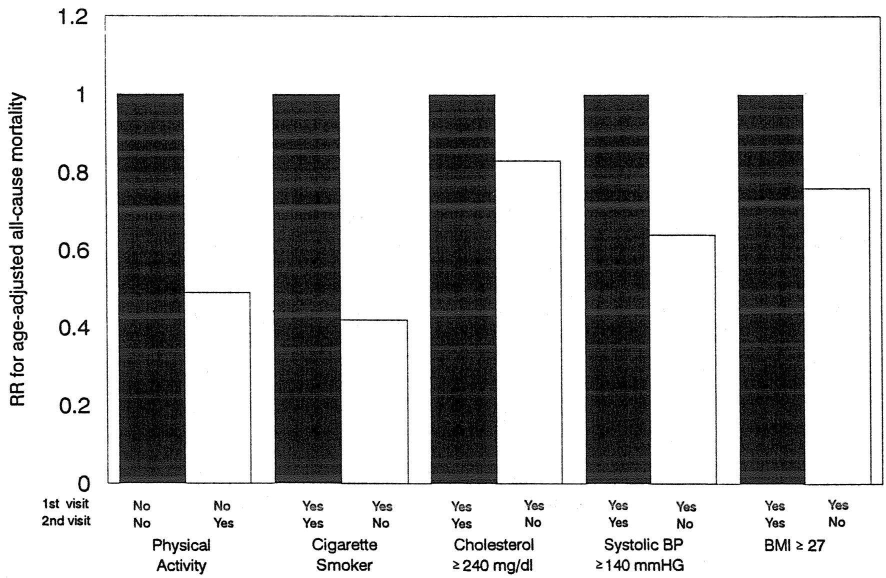

Figure 7 — Relative risks (RRs) for age-adjusted all-cause mortality are shown for changes in lifestyle characteristics in 10,288 men with two examinations at the Cooper Clinic during 1970 to 1989. There were 275 deaths during 52,069 man-years of follow-up. Black bars represent men who were at risk on the variable at both examinations, and white bars represent men who made favorable changes in risk factors from the first to the second examination. BP = blood pressure; BMI = body mass index. *Note.* From "1993 C.H. McCloy Research Lecture: Physical Activity, Physical Fitness, and Health," by S.N. Blair, 1993, *Research Quarterly for Exercise and Sport, 64*, p. 370. Copyright 1993 by the American Alliance for Health, Physical Education, Recreation and Dance. Reprinted with permission.

to explore more fully the relation of exercise intensity to risk of morbidity and mortality. The principal unanswered question is whether higher intensity exercise provides additional risk reduction over moderate intensity exercise, when the total amount of exercise is held constant.

The Public Health Effect of a Sedentary Lifestyle

Studies reviewed in the previous section provide strong evidence that sedentary and unfit individuals are at a substantially higher risk for morbidity and mortality, especially for cardiovascular diseases, some cancers, and non-insulin-dependent diabetes mellitus. These findings alone, however, do not give a complete view of the public health importance of sedentary living habits. To address this latter issue, it is necessary to estimate the population burden of physical inactivity. Epidemiologists and public health officials do this by calculating population attributable risks (PAR). PAR for physical inactivity is derived from calculations that involve both the strength of the association between inactivity and mortality and the prevalence of inactivity in the population. It is intuitively easy to grasp the fundamental concepts at work in this calculation. The stronger the relation between a risk factor and death, the higher the PAR; and the more common the risk factor in the population, the greater the PAR. For example, a characteristic that increased risk of death 10-fold could have a sizable PAR even if it was uncommon, perhaps with only 10% of the population being at risk. Conversely, if a risk factor occurs frequently in the population, say in 60 to 70% of the group, it would have a substantial PAR if it had a relative risk (RR) of 1.5 (a 50% increase in mortality risk).

There are three recent reports on the PAR of physical inactivity for mortality in the U.S. (Hahn, Teutsch, Rothenberg, & Marks, 1990; McGinnis & Foege, 1993; Powell & Blair, 1994). The investigators typically used RRs of 2.0, and a population prevalence of physical inactivity of 20 to 25%. The estimated number of coronary heart disease, diabetes, and colon cancer deaths due to sedentary lifestyle is estimated at 200,000 to 250,000 in the various reports. These figures may well be underestimates because they are based on the RR observed in physical activity studies. Studies on physical fitness and mortality typically show higher RRs (Blair et al., 1989; Ekelund et al., 1988), probably due to a more accurate measure of risk exposure in the fitness studies. Nonetheless, the available PAR estimates show a substantial population burden of physical inactivity, and one that is comparable to other established risk factors such as obesity, hypertension, and elevated cholesterol.

How much reduction in mortality could actually be expected from changes in physical activity in the population? Theoretically, if everyone became physically active, the PAR for sedentary habits would drop to zero; however, it is unrealistic to expect that all sedentary persons will adopt regular and vigorous exercise. We estimate that if 50% of the currently sedentary adults in the U.S. would become even somewhat active, the number of deaths from coronary heart disease, colon cancer, and diabetes would fall by approximately 22,000 per year. This amount of change in population physical activity habits might be achievable with a well-planned and well-executed health promotion campaign. More extensive changes in activity patterns, with more individuals becoming moderately active and some becoming highly active, would be expected to have an even greater impact.

Recommendations for Promoting Physical Activity for Health

Major scientific and public health organizations are involved in promoting physical activity as part of an overall health enhancement strategy. Recent initiatives by the American Heart Association, ACSM, and units of the U.S. Public Health Service such as the Centers for Disease Control and Prevention (CDC) underscore the public health burden of sedentary living habits and the importance of increasing activity levels of Americans (Blair, 1993). It is evident that we need new tools and new strategies to reach the millions of individuals who remain physically inactive. The traditional approach to exercise prescription is valid and is based on sound science. Unfortunately, this approach is often perceived as too vigorous, too regimented, and perhaps too intimidating to be attractive to many sedentary men and women. Thus, we must seek other ways to help these individuals become more active.

A recent recommendation by the ACSM and CDC offers an alternative to the traditional exercise prescription (Pate et al., 1995). This new recommendation is not intended to replace earlier statements on exercise, but should be viewed as complementary. In fact, the total weekly caloric expenditure in physical activity is approximately the same for both the traditional and life-style methods. The specific new recommendation is as follows: ''Every U.S. adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week'' (Pate et al., 1995, p. 402). Some of the key features of this recommendation are the focus on moderate-intensity activity and the concept of *accumulating* the activity over the day, rather than in a single exercise session. This gives individuals more flexibility in managing their physical activity program. There is an emphasis on becoming more active as a part of daily life, by taking stairs instead of an elevator or escalator, looking for opportunities to fit in a few minutes of walking, seeking more active recreational and leisure-time activities, and trying to become generally more active by sitting less. The focus on moderate intensity may be more appealing to many, especially those who dislike vigorous exercise.

Summary and Conclusion

There is ample evidence that physical activity is a good health habit, and should be more widely encouraged and promoted. Millions of Americans are essentially totally sedentary, and thus the population burden of sedentary living is high, leading to higher than necessary rates of several chronic diseases and overall mortality. There is little difference between exercising for physical fitness and exercising for health. The key factor is the total energy expenditure of the activity. Both the traditional exercise prescription and the newer recommendations for increasing life-style exercise should be promoted. Many individuals will find one of these two approaches appealing.

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