The Risks of Exercise: A Public Health View of Injuries and Hazards

JEFFREY P. KOPLAN, MD
DAVID S. SISCOVICK, MD
GARY M. GOLDBAUM, MD

Dr. Koplan is Assistant Director for Public Health Practice in the Office of the Director, Centers for Disease Control (CDC), Atlanta, GA. 30333. Dr. Siscovick is Assistant Professor of Medicine in the Division of General Medicine and Clinical Epiemiology, University of North Carolina School of Medicine, Chapel Hill, NC 27514, and is a Teaching and Research Scholar of the American College of Physicians. Dr. Goldbaum is a Medicial Epidemiologist in the Behavioral Epidemiology and Evaluation Branch, Division of Health Education, Center for Health Promotion and Education, CDC.

Tearsheet requests to Dr. Koplan.

Synopsis

Relatively little is known about the incidence of the risks facing those who exercise regularly. Clinical reports suggest a variety of musculoskeletal ailments, and several pathophysiologic conditions may result from the various aerobic activities most likely to be pursued by large parts of the U.S. population. But adequate epidemiologic data are scarce. Careful epidemiologic studies are needed to develop incidence information.

THE PUBLIC HEALTH ATTITUDE toward exercise has altered considerably over the past 10 years. Formerly, exercise was regarded as outside the realm of public health influence and health department activities (*1*). Now physical activity in general and exercise in particular are considered crucial elements of health promotion (*2*), itself a recent but major aspect of our discipline. Our advocacy of exercise as a route to physical fitness and as a potential risk reducer for a variety of ailments, primarily cardiovascular, is based on biologic and epidemiologic observations. However, little attention has been focused on the risks of such exercise. The purpose of this paper is to examine what data do exist on the incidence of the risks of exercise, particularly on injuries and hazards, and to identify what additional data are needed.

The term "injuries" refers to physical damage, usually musculoskeletal but also including frostbite, lacerations, and corneal abrasions. The criteria for defining an injury vary by investigator and study, and a general definition that could be applied for all studies is difficult to create.

At one extreme, one could require physician diagnosis with radiographic or other diagnostic test confirmation when possible. However, many exercise-related injuries are not brought to the attention of a physician. Thus, injury incidence might be incomplete if based solely on physician reports.

A less medically oriented approach is to allow the participant to define his or her own injury and then classify it by degree of disability, with less concern for diagnostic category. For example, we could consider an injury to be an adverse event, related to exercise, that causes soft tissue, joint, or bone pain or inflammation sufficient to cause the participant to decrease the quantity or intensity of his or her exercise program. The injury could then be further classified as severe enough to force the participant to cease exercising, seek medical care, or miss work.

We consider "hazards" to be other ailments, particularly physiologic dysfunctions associated with exercise. For example, acute hazards might include dehydration or hypoglycemia, while chronic hazards might include amenorrhea or osteoporosis.

We will narrow the focus of this study in three ways:

1. Although exercise is a public health concern and objective in all age groups, we will concentrate on adult studies.
2. We will discuss six of the most popular aerobic exercises (*3*) because they meet the definition of "appropriate physical activity" as defined in the 1990 objectives of the Public Health Service (*2*): ". . . exercise which involves large muscle groups in dynamic movement for periods of 20 minutes or longer, three or more days per week, and which is performed at an intensity requiring 60 percent or greater of an individual's cardiorespiratory capacity" (*2*). These six activities (walking, swimming,

Table 1. Factors that may influence the occurrence of injuries in several types of exercise

Host factors	Exercise factors	Environmental factors
	Swimming	
• Age • Sex • Habitus (ear canal anatomy)	• Stroke • Technique • Frequency • Speed • Distance • Duration • Warmup-cool down	• Body of water (pool, lake, ocean) • Temperature • Water quality (pH) purity, chlorine)
	Running, Walking	
• Age • Sex • Habitus, (weight; height; varus-vulgus)	• Gait • Frequency • Speed • Distance • Duration • Pre- or post-exercises	• Location • Surface (composition; slant) • Shoes • Air temperature • Humidity
	Cycling	
• Age • Sex • Habitus	• Frequency • Speed • Distance • Duration • Pre- or post-exercises	• Bicycle (toe clips; ratios of parts) • Air temperature • Humidity • Wind • Road surface • Inclines-declines • Type road • Helmet use
	Calisthenics	
• Age • Sex • Habitus	• Type of exercise • Frequency • Duration • Warmup–cool down	• Surface

calisthenics, cycling, running, and racquet sports) can be expected to promote cardiovascular fitness when properly performed (*4*).
3. We will focus on physical injuries, recognizing that these represent only part of the risk of exercise.

To consider "exercise" a health-promoting practice already implies that we have prejudged its benefits as outweighing its risks. Indeed, tens of millions of people have already made this judgment, as they regularly engage in a variety of aerobic exercise activities. However, if health professionals are to promote exercise objectively, they need to provide consumers with a balanced view. This should be done for health care technologies, such as diagnostic tests, operative procedures, pharmaceuticals, and vaccines. And it should be done for health-promoting activities, such as seatbelts, airbags, diets, and exercise. Thus, to encourage and even prescribe exercise, we should have a firm grasp of both its benefits and its risks.

However, the existing literature on the risks of exercise is inadequate to this task. It comprises several types of reports:

1. The anecdotal case report or collection of case reports, published as a clinical "series," for example, for risks, an anatomic litany of runners' knees, ankles, tendons, nipples, and so forth. Although the clinical literature is extensive, these studies lack the perspective of the population at risk; that is, there is no denominator population. However, they do enable epidemiologists to focus on injuries associated with the exercise.
2. The physiological study that describes exercise in terms of maximum oxygen consumption, ergs, and kilocalories and focuses on the acute performance of the musculoskeletal and cardiorespiratory systems under stress.
3. The clinical commentary that advocates certain practices or warns against others, usually based on the anecdotal case report and the physiological study.
4. The epidemiologic study that produces rates of injuries, a time frame, and factors associated with the injuries. Population–based surveys, case-control investigations, and cohort studies are in this category.

Although the last category is the most helpful in objectively assessing the potential risks of exercise, it has the shortest reference list. Kraud and Conroy recently wrote an exhaustive review of morbidity and mortality data for a variety of sports and age groups (*5*). Unfortunately, this review identifies few epidemiologic studies providing data on the risks associated with the aerobic activities that most people would choose to improve fitness.

One of the impediments to the evaluation of the risks of exercise is the complexity of the exercise itself (*6,7*). People who undertake physical activity or exercise do so at various levels of intensity and performance, with various attributes, and with a variety of risk factors. People who exercise are thus a heterogeneous lot, and their risks probably are best considered for subgroups of the whole. This problem of classification is analogous to the infectious disease epidemiologic model of host, agent, and environment in which the interplay of these factors determines outcomes.

Using running as an example, potentially important host factors are age, sex, level of fitness, prior health status, other risk factors (family history, smoker), and body habitus. We can consider the agent in this example to be the actual practice of running; it varies by factors such as speed, duration, frequency of workouts, and warmup time. Environmental factors include climate, terrain, foot gear, location of practice, and running surface. Other sports can be similarly analyzed (table 1).

Of course, these variables by host, agent, and environment can be applied to individual persons, all of whom will be unique. But, for broad subgroups, risks and benefits may be more uniform within the subgroup and considerably different from subgroup to subgroup. Climate is an obvious differentiating factor, with the risks of frostbite and heat prostration varying across the country. Yet persons who have run regularly for 10 years may have very different risks from those beginning the activity. Rates of injury may be greater among longer-distance runners than among 10 mile–per–week runners.

In short, there are remarkably few population-based data available on morbidity, mortality, or associated risk factors for exercise in general, and even fewer for aerobic exercise in particular. Data on walking, swimming, and cycling are further complicated by the fact that the way in which these activities are performed is not the way exercise has been defined for the papers from this workshop. Let us examine existing epidemiologic data on the most popular forms of aerobic exercise.

Exercise-Specific Risks

Walking. The 1979 Perrier fitness study (*3*) estimated that 34.1 million Americans consider regular walking a major form of physical activity; however, the proportion who walk for exercise is not known. Similarly unknown are the injuries and hazards associated with walking and the rates at which they occur. We hypothesize that walkers share similar risks with runners; however, the degree of similarity has not been demonstrated.

Swimming. It is estimated that more than 26 million persons swim regularly (*3*). But how much swimming is splashing in the surf or floating on an inner tube for fun and how much is swimming pool laps or openwater distances for aerobic exercise is unknown. It is likely that the latter type of swimming represents only a small fraction of the total number of persons who "swim." Thus, interpreting risk data is difficult.

In 1980, a total of 7,000 persons reportedly died while swimming (*8*). It is unlikely that most of the

'Exercise was heretofore regarded as outside the realm of public health influence and health department activities. Now, physical activity in general and exercise in particular are considered crucial elements of health promotion, itself a recent but major aspect of our discipline.'

persons who died were swimming for exercise. Furthermore, it has been shown that in 36 percent of drownings in Georgia, the victim was legally intoxicated (*9*). Drinking alcohol and swimming for exercise are inconsistent. Also, because most swimming for exercise requires considerable swimming skill and usually a supervised pool facility, the opportunity to drown is minimized. There are simply no reliable data on the mortality risks of swimming for exercise.

In terms of morbidity, swimmer's ear, conjunctivitis, dental enamel erosion (*10*), and musculoskeletal injuries, particularly involving the shoulder (in up to 50 percent of competitive swimmers) (*11*), have all been described. However, there are no data on prevalence, incidence, or natural history of these or other adverse events in noncompetitive swimmers.

Calisthenics. There are 21.7 million Americans estimated to engage in calisthenics regularly (*3*). Aerobic dancing—rhythmic calisthenics performed to music—is an increasingly popular form of exercise. Despite the large number of participants, there is no systematic collection of statistics on injuries associated with calisthenics. In a recent survey of injuries occurring during aerobic dance classes, 36 percent of injuries were below the knee; 76 percent of these were stress fractures or tibial stress syndrome (*12*). Knee injuries comprised another 35 percent of the total.

Running-jogging. It is estimated that 17.1 million persons run regularly (*3*) for exercise. Again, the levels of exertion vary considerably, as do several other variables that may influence relative risks and benefits.

Few studies address these issues and provide quantitative data on the risks of running. A study of runners in the Peachtree Road Race suggests that

'If we are to continue advocating exercise as a health-promoting activity, it is our responsibility as advocates and health professionals to provide the public with information that presents a full and balanced view of exercise, namely, its benefits and risks.'

running is associated with losing weight and quitting smoking (*3*). However, this association may be related to a selection phenomenon rather than a causal relationship. The risks of running, however, include a 1 in 3 chance of being injured and a 1 in 10 likelihood of an injury that requires medical attention per running year. The authors of the study noted that risks of injury are associated with increasing mileage and conclude that a possible balance of risks and benefits might occur at a certain level of distance or intensity or both. This "optimal level" might be a mileage that contributes to a total energy expenditure of 2,000 kilocalories, as recommended by Paffenbarger and colleagues for a cardiovascular benefit (*14*), while limiting the risk of musculoskeletal injury.

In a case-control study of heat injury in runners, runners with heat injury were more likely to be taller, slower, and run less in hot weather than those in the control group (*15*). The authors suggest approaches to lowering the risk of heat injury.

Cycling. Although 20.2 million persons are estimated to engage in recreational bicycling (*3*), the numbers who do so for aerobic exercise are undetermined but clearly only a fraction of the total. A population-based assessment of cycling risks was done in a university setting using a random sample of 1,200 students with a 71 percent response rate (*16*). Although 63 percent of respondents stated that they used a bicycle, only 17 percent cycled daily. Many of the students only used their bicycles during part of the year. For most of the respondents, cycling was primarily a means of transportation (average of 13.6 miles per week) and secondarily a means of recreation (6.4 miles per week). Almost a third of the cyclists had an accident in the previous 3–year period, with 13 percent of accidents occurring in the past year. Sixty–two percent of accident victims were injured, and of those injured, 32 percent sought medical attention. The study considered various risk factors for accidents.

Lacerations and abrasions of upper and lower limbs comprised 64 percent of all injuries in one study of urban cyclists (*17*). Head injuries and fractured extremities are a particular hazard of cycling, but their rates and relation to host-agent-environmental classifications are ill defined.

Racquet sports. It is estimated that in 1978, a total of 14.0 million people played tennis, 3.1 million racquetball, 3.1 million badminton, and 1.6 million squash (*3*). In 1980, nearly 187,000 medically attended injuries related to racquet sports were reported for persons over 14 years old (*18*). Eye injuries are a particularly serious and much reported hazard (*19,20*), but probably not the most common. In a retrospective survey of squash players at two New York clubs, 44.5 percent of those surveyed indicated then they had been injured during their playing history (*21*). The lower extremity was most commonly injured, but facial and eye injuries were also frequent. However, the study did not define injury and was unable to provide incidence figures. Exercise benefits were not discussed.

Among a variety of musculoskeletal ailments in tennis players, "tennis elbow" (epicondylitis lateralis humeri) has an incidence rate of 9 percent, based on a survey of club players (*22*). Measures to prevent this disorder, such as changing grip size or exercises, have been suggested but not studied for their effectiveness.

A survey of British club badminton players demonstrated an injury incidence rate of .09 per male and .14 per female per year, mostly leg strains and sprains, blisters, and cramps (*23*).

Discussion

A summary of the adverse events reported in clinical series and epidemiologic studies is provided in table 2. It is clear that, even for these most common aerobic exercises, few data exist to offer an objective and quantitative estimate of risks. In addition, most of the available data concern acute injuries and hazards. The long-term musculoskeletal effects of regular exercise have not been studied. For instance, what is the relationship of many years of running to osteoarthritis of knees and hips?

Following are the study problems and needs common to all the forms of exercise discussed:

1. *Lack of definitions.* Studies on exercise and injuries are published without definitions of injury or

Table 2. Injuries in exercise by type of study[1]

Exercise	Clincial study	Epidemiologic study
Swimming (*10,11*)	Otitis externa; muscle strains and tears; shoulder pain; dental enamel erosion; conjunctivitis	No studies
Running (*13,15*)	Musculoskeletal ailments such as chondromalacia, achilles tendonitis, shin splints, stress fractures; heat exhaustion	38 percent of runners injured per year; one-third of injuries to knee; data on factors associated with heat exhaustion
Walking	No studies	No studies
Cycling (*16,17*)	Head injuries; fractured limbs; abrasions; lacerations	13 percent accident rate per year; 62 percent of cyclists in accidents were injured, one-third of whom sought medical care
Calisthenics (*12*)	Lower leg, foot, and ankle injuries	No studies
Racquet sports (*18–22*)	Head, eye, and leg injuries; tennis elbow	44.5 percent injured during playing history; 9 percent incidence of tennis elbow

[1] Numbers in parentheses indicate reference numbers.

without defining what constitutes regular exercise.

2. *Poor characterization of subgroups within each form of exercise.* Given the heterogeneous nature of swimmers, runners, or other exercisers, the participants need to be defined by common characteristics—for example, swimmers who log more than 3 miles per week, runners who log 20 to 30 miles per week, runners who are obese compared with those who are lean. When data are collected for a broad category of exercise, they should be stratified for such subgroups.

3. *Lack of denominator data.* Cases of injury or events are described but not put in the context of population at risk.

4. *Lack of controls.* Cases of an injury or event are described but not compared with appropriately matched controls. Without controls, determining risk factors or intervention measures is more hypothetical than scientific.

5. *Lack of time perspective.* Even when an injury rate per population at risk is provided, often it is not placed in a time interval such that one could determine an incidence—for example, 7 injuries per 1,000 participants per year.

6. *Selection bias.* When a study of exercise participants is undertaken, we only see the adherents. Already missing are the people who have determined that, for them, the risks of the activity outweigh the benefits. Thus, we are left studying a group smaller than the original cohort, depleted by those more likely to have been injured or possibly less likely to have lost weight or to have quit smoking.

7. *Lack of risk-benefit comparisons.* Whatever the exercise, both short- and long-term benefits need to be documented and quantitatively related to the risk. A potential participant should be able to consider the alternatives to running, swimming, or a racquet sport, knowing the time requirements to achieve specific benefits; the rates of injury per comparable time unit; the rates of attrition from the exercise and the reason for stopping; the benefits in terms of muscular strength, weight control, cardiorespiratory fitness, or participant satisfaction; the economic costs; and the convenience.

8. *Paucity of suitable data sources.* Routine collection of health and disease indicators provides little information on injuries associated with exercise. Mortality data may associate deaths with swimming, cycling, or being a pedestrian, but they do not distinguish whether the activity is for exercise, transportation, or some other purpose. Injuries associated with exercise are not routinely collected and identified by this association. Data on injuries are obtained in the National Electronic Injury Surveillance System (NEISS) conducted by the Consumer Product Safety Commission. However, the data are limited to product-related injuries reported from a sample of 199 hospital emergency rooms. For exercises such as swimming, running, walking, and calisthenics, there may be no product involved to elicit reporting of an injury.

Conclusions

Given the information we have regarding injuries during exercise (table 2), the problem we have identified in collecting data, and our continued needs for data on the risks of exercise, how should we proceed?

First, we need a community-based survey (or many such surveys with uniform data collection) on exercise which would ascertain type of exercise, frequency, duration, level of intensity, and, if possible, information on injuries. This survey would provide an estimate of the number of people participating in different types of exercise and enable us to define better the categories of participants within each exercise subgroup. Swimmers would then be defined by arbitrary but consistent minimal criteria, such as a person who swims 500 yards or more at least three times a week. Similarly, criteria would be set for defining other forms of exercise.

To obtain better information on injury rates as well as attrition from the activity, and documentation of benefits, it would be useful to develop some cohorts who could be followed over time so that we could develop information on the natural history of various exercise forms. Thus, a sample of persons in the community survey could be followed after collection of the baseline data. The baseline data would give us a randomly selected set of people representing a spectrum of levels of physical activity and exercise. As they increase or decrease their levels, change weight or smoking habits, or become injured or ill, the relationships between these activities and measurements could be studied. In so doing, we would develop incidence rates of injuries, quantitative estimates of many risks and benefits, and a sense of who persists in exercise and why, as well as who drops out and why).

Unfortunately, cohort studies can be expensive to maintain, and regular followup, over time, of such a group can be expensive to maintain. But studies of more accessible populations, such as road race participants or members of swim or bicycling teams, are subject to significant selection bias. Cohorts selected from population-based surveys provide a more complete view of swimming, walking, or cycling as physical activity versus exercise, and in so doing show how these definitional distinctions may also confer different benefits and risks to the activity.

Of course, there are many other approaches that can be taken to provide epidemiologic information on exercise. Case-control studies can yield data on risk factors for specific injuries. They are less expensive than surveys or cohort studies and are efficient for getting discrete pieces of information.

For a complete evaluation of the benefits versus the risks of exercise, it is necessary to establish a common denominator for benefits and risks. Improved muscle strength, "feeling better," and cardiopulmonary capability are not easily compared to Achilles tendonitis, motor vehicle collisions, and otitis externa.

There are major qualitatitive and quantitative differences between these events and great differences in their probabilities. A utility analysis (in which these factors would be incorporated into a common denominator such as quality-adjusted life years) might be useful in assessing relative benefits and risks. The utility analysis would ascertain how persons value the various benefits and risks, place these values in context through their probabilities, and express the results in a unit such as quality-adjusted life years.

If we are to continue advocating exercise as a health-promoting activity, it is our responsibility as advocates and health professionals to provide the public with information that presents a full and balanced view of exercise, namely, its benefits and risks. The scientific quality and quantity of our current information on exercise risks and public health are limited. If we are to maintain professional credibility, we must assess exercise risks with the same rigor that we demand of benefit analysis.

What is known

1. Clinical series have identified the injuries most likely to be associated with particular forms of exercise.
2. Injury rates can be expected to be related to the form, frequency, and intensity of the activity as well as to the characteristics of both the environment and the person undertaking the activity.

Recommendations for studies

For the commonly performed aerobic exercises, such as walking, swimming, calisthenics, running, cycling, and racquet sports:

1. Design a study which would permit the initial evaluation and subsequent followup of a mixed population of persons, some of whom exercise and some of whom are sedentary, and who can be clearly characterized for a variety of demographic, lifestyle, and physiological attributes.
2. Using such a study design: (*a*) determine the incidence of acute and chronic musculoskeletal problems and determine associated risk and protective factors; (*b*) determine the incidence of other pathologic conditions, for example; endocrinologic and metabolic; (*c*) characterize the subgroups in the population most susceptible to the identified adverse effects; and (*d*) compare the risks and benefits using a utility analysis.

References

1. Terris, M.: Approaches to an epidemiology of health. Am J Public Health 65: 1037–1045 (1975).
2. Department of Health and Human Services: Promoting health/preventing disease: objectives for the nation. U.S. Government Printing Office, Washington, DC, fall, 1980.
3. The Perrier study: fitness in America. Perrier-Great Waters of France, Inc., New York, 1979.
4. American College of Sports Medicine: Position statement on the recommended quantity and quality of exercise for developing and maintaining fitness in healthy adults. Sports Med Bull 13: 1–4 (1978).
5. Kraus, J. F. and Conroy, C.: Mortality and morbidity from injuries in sports and recreation. Annu Rev Public Health 5: 163–192 (1984).
6. Caspersen, C. J., Powell, K. E., and Christenson, G. M.: Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep 100: 126–131, March-April 1985.
7. LaPorte, R. E., Montoye, H. J., and Caspersen, C. J.: Assessment of physical activity in epidemiologic research: problems and prospects. Public Health Rep 100: 131–146, March-April 1985.
8. Aquatic deaths and injuries—United States. MMWR 31: 417–419, Aug. 13, 1982.
9. Alcohol and fatal injuries—Fulton County, Georgia, 1982. MMWR 32: 573–576, Nov. 11, 1983.
10. Erosion of dental enamel among competitive swimmers—Virginia. MMWR 32: 361–362, July 22, 1983.
11. Richardson, A. B., Jobe, F. W. and Collins, H. R.: The shoulder in competitive swimming. Am J Sports Med 3: 159–163 (1980).
12. MacIntyre, J. G., et al.: A survey of injuries in exercise to music classes. Presented at the Annual Meeting of the American College of Sports Medicine San Diego, CA 1984.
13. Koplan, J. P., et al.: An epidemiological study of the benefits and risks of running. JAMA 248: 3118–3121 (1982).
14. Paffenbarger, R. S., Wing, A. L., and Hyde, R. T.: Physical activity as an index of heart attack risk in college alumni. Am J Epidemiol 108: 161–175 (1978).
15. England, A. C., et al.: Preventing severe heat injury in runners: suggestions from the 1979 Peachtree Road Race experience. Ann Inter Med 97: 196–201 (1982).
16. Kruse, D. L., and McBeath, A. A.: Bicycle accidents and injuries. Am J Sport Med 8: 342–344 (1980).
17. Sgaghone, N. A., Suljaga-Petchel, K., and Frankel, V. H.: Bicycle-related accidents and injuries in a population of urban cyclists. Bull Hosp Jt Dis Orthop Inst 42: 80:-91 (1982).
18. Rutherford, G. W., Miles, R. B., Brown, V. R. and MacDonald, B.: Overview of sports related injuries to persons 5–14 years of age. U.S. Consumer Product Safety Commission, Washington, DC, December 1981.
19. Easterbrook, M.: Eye injuries in racket sports. Int Opthalmol Clin 21: 87–119 (1981).
20. Vinger, P. F.: The incidence of eye injuries in sports. Int Opthalmol Clin 21: 21–46 (1981).
21. Berson, B. L., Rolnick, A. M. Ramos, C. G., and Thornton, J.: An epidemiologic study of squash injuries. Am J Sport Med 9: 103–106 (1981).
22. Gruchow, H. W., and Pelletier, D.: An epidemiologic study of tennis elbow. Am J Sport Med 7: 234–238 (1979).
23. Hensley, C. D.: A survey of badminton injuries. Br J Sports Med 13: 156–160 (1979).

The Relation of Physical Activity and Exercise to Mental Health

C. BARR TAYLOR, MD
JAMES F. SALLIS, PhD
RICHARD NEEDLE, PhD

Dr. Taylor is associate professor of psychiatry (clinical) in the Department of Psychiatry and Behavioral Sciences, Stanford University School of Medicine, Stanford, CA 94305. Dr. Sallis is assistant adjunct professor, Division of General Pediatrics, University of California at San Diego, La Jolla. Dr. Needle is associate professor, College of Education and School of Public Health, University of Minnesota, St. Paul.

Tearsheet requests to Dr. Taylor.

Synopsis

Mental disorders are of major public health significance. It has been claimed that vigorous physical activity has positive effects on mental health in both clinical and nonclinical populations. This paper reviews the evidence for this claim and provides recommendations for future studies.

The strongest evidence suggests that physical activity and exercise probably alleviate some symptoms associated with mild to moderate depression. The evidence also suggests that physical activity and exercise might provide a beneficial adjunct for alcoholism and substance abuse programs; improve self-image, social skills, and cognitive functioning; reduce the symptoms of anxiety; and alter aspects of coronary-prone (Type A) behavior and physiological response to stressors. The effects of physical activity and exercise on mental disorders, such as schizophrenia, and other aspects of mental health are not known. Negative psychological effects from exercise have also been reported. Recommendations for further research on the effects of physical activity and exercise on mental health are made.