

## Research on Physical Activity and Health among People with Disabilities: A Consensus Statement

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**Abstract--**Research is required to advance the understanding of issues related to the effect of physical activity on health and disease prevention among people with disabilities. This report is the result of a consensus process using selected experts in health and exercise. The purpose of the consensus conference was to identify research priorities for physical activity and health among people with disabilities. Priorities were established by 30 participants, who were selected by the principal investigators to achieve balance in the areas of engineering, epidemiology, medicine, nutrition, exercise physiology, and psychology. Experts summarized relevant data from their research and from comprehensive review of the scientific literature on the topic areas chosen for the conference. Public commentary was provided by participants in the 1996 Paralympic Congress. Panel members discussed openly all material presented to them in executive session. Commentary from open discussion periods were recorded and transcribed. Selected panelists prepared first drafts of the consensus statements for each research priority question. All of these drafts were distributed to the panelists and pertinent experts. The documents were edited by the drafting committee to obtain consensus. This research priority setting process revealed that greater emphasis must be placed on determining the risks and benefits of exercise among people with disabilities. Exercise must be studied from the perspective of disease prevention while mitigating risk for injury. Five areas were identified as focal points for future work: epidemiological studies; effects of nutrition on health and ability to exercise; cardiovascular and pulmonary health; children with disabilities; and accessibility and safety of exercise programs. As

people with disabilities live longer, the need for addressing long-term health issues and risk for secondary disability must receive greater attention. As a consequence of the consensus process, specific recommendations for future research regarding the impact of exercise on the health and quality of life of persons with disabilities were defined.

**Key words:** *disability, exercise, health, paralympics, research priorities.*

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## INTRODUCTION

Disability affects nearly 49 million Americans and has tremendous impact on the United States healthcare system (1). Disability within this statement is defined as an impairment that limits one or more activities of daily living. Much is known about the benefits of regular physical activity in the general population; including improvement in levels of physical functioning (e.g., aerobic capacity) and numerous health benefits. There is also significant knowledge about the detrimental physiological effects of inactivity on both physical functioning and health. The Surgeon General's Report on Physical Activity and Health provides recommendations for moderate activity commensurate with good health, for example, 1000 or more kilocalorie expenditure per week (2). These recommendations are primarily intended for unimpaired people. Less is known about how to design and disseminate programs of exercise for persons with disabilities. Yet, optimizing physical activity for people with disabilities may be even more important to their general welfare. Disabilities commonly cause "a cycle of deconditioning" in which physical functioning deteriorates, leading to further reduction in physical activity levels.

## PURPOSE

The purpose of this consensus process was to examine the accumulating evidence on the role of physical activity in promoting health and fitness among people with disabilities. Physical activity is defined in this statement as "bodily movement produced by skeletal muscles that requires energy expenditure" and produces health benefits. Exercise, a type of physical activity, is defined here as "a planned, structured, and repetitive bodily movement done to improve or maintain one or more components of physical fitness." Physical inactivity denotes a level of activity less than that needed to maintain good health. This consensus conference focused on five areas:

epidemiology, cardiovascular health, pulmonary health, nutrition, and risk factors.

People with disabilities who may be close to or below the threshold of being able to manage basic activities of daily living (ADLs) and the functions necessary for their accomplishment are at particular risk of inactivity (i.e., may be more prone to sedentary lifestyles). Even small reductions in stamina or capacity can negatively impact the ability to dress, bathe, eat, or walk without assistance (3). The loss or reduction in independence in such basic activities hampers personal freedom, reduces autonomy, and leaves the person more vulnerable to the detrimental physiologic and psychological effects of, and secondary conditions associated with, physical inactivity. Loss of such independence also impacts strongly on the costs of and need for long-term care services. This report presents the results of an NIH consensus panel on optimizing the physical activity and health of children and adults with disabilities.

## **METHODS**

The objective of this consensus process was to identify research priorities required to advance the understanding of issues related to the effect of physical activity on health and disease prevention among people with disabilities. Considerable new information has been developed regarding physical activity and health in the general population. However, there is a paucity of data and research on the benefits and risks of physical activity among the population of people with disabilities. This consensus statement addresses issues related to research in physical activity for people with disabilities and identifies areas that require further investigation.

### **Consensus Panel Participants**

The 30 participants were selected by the consensus conference organizers to achieve balance in the areas of engineering, epidemiology, medicine, nutrition, exercise physiology, and psychology. Participants were distributed to represent people with disabilities, clinicians, and researchers. The consensus panel members communicated by telephone prior to the 2-day meeting and then corresponded for 3 months after the meeting. During the 2-day meeting, the panel members formulated and discussed the general topic areas for the consensus conference. Panel members and selected experts were asked to submit statements in writing prior to the consensus conference held in conjunction with the 1996 Paralympic Congress. The panel members listened to a set of presentations with background papers from selected experts. Attendees of the 1996 Paralympic Congress were given the opportunity to provide comment during open discussion periods.

### **Review of Evidence**

Selected experts summarized relevant data from the national and international scientific literature on the topic areas chosen for the conference. In addition, public commentary was provided by participants in the 1996 Paralympic Congress. Panel members reviewed the scientific literature, the data presented by the selected experts, and the transcripts of the public commentary to create this consensus paper.

### **Consensus Process**

Panel members discussed openly all material available to them in executive session. Commentary from open discussion periods was recorded and transcribed. Selected panelists prepared first drafts of the consensus statements for each topic area. All of these drafts were distributed to the panelists and the experts selected to participate in this consensus process. A subcommittee of the panelists compiled the drafts to create a consensus statement. The full panel reviewed and edited the consensus statement.

## **EPIDEMIOLOGY**

Exercise participation varies by diagnosis among people with disabilities. There are variations across disabilities based upon demographic characteristics, including age, gender, and other sociodemographic variables (4). The published literature tends to focus on people post spinal cord injury. Comparisons of life adjustment scores including measures of social and vocational activities show several consistent differences in adjustment between survivor and deceased groups, all of which suggest that survivors tend to have made adjustments superior to those made by those who had died. People who survive a severe physical impairment long-term are likely to be employed and to leave their homes frequently on social outings. In addition, long-term survivors report higher overall levels of self-created adjustment, as well as greater satisfaction with several areas of their lives, including their living arrangements, employment, finances, sex life, and general health. Further study has shown that long-term survivors report significantly less emotional distress and dependency, as well as greater activity, and more satisfaction than deceased participants had reported. In summary, these prospective studies clearly suggest that an overall active and satisfying lifestyle is related to greater longevity. Activity is highly correlated with length of survival.

Sports and recreational activities have led to an increase in quality of life and awareness of the needs to integrate people with disabilities into society (5). Fitness and recreational opportunities for people with disabilities have been increasing every year. However, descriptive investigations of injury patterns among athletes with disabilities have found similar injury trends among nondisabled athletes. Athletes with disabilities have been found to have an injury rate of 9.45/1000 athlete-exposures (e.g., training sessions, competitions). Overall, 52 percent of the reported injuries were minor (0-7 days of time-loss), 29 percent were moderate (8-21 days of time-loss), and 19 percent were major (22 or more days of time-loss) (6). Musculoskeletal injuries to the shoulder, knee, and wrist/hand/fingers complex were the most commonly reported locations. Additionally, illness and disability related problems caused a reduction in participation time. Fifteen percent of the moderate and major injuries were not medically evaluated which raised questions about access to medical care and appropriate injury recognition. Data are required to compare health status and frequency of injury between athletes with disabilities and the broader spectrum of people with disabilities. There are indications that the prevalence of some injuries may be similar between athletes and non-athletes (7).

### *Recommended Research*

1. Explain the compounding impact of physical activity on medical illness among people with disabilities.
2. Characterize, from the cellular level to the behavioral level, the impact of physical activity on aging with a disability.
3. Discriminate between pain originating from sports injuries and pain from a pre-existing physical impairment.
4. Determine factors that effect motivation of people with disabilities to participate regularly in physical activity, including access to exercise (i.e., organizations, facilities, and appropriate equipment).
5. Determine the relationship between type and intensity of activity with regard to longevity and quality of life.
6. Investigate exercise programs and performance techniques to reduce incidence of injuries.
7. Characterize the physical activity patterns of people with disabilities.

## **ACHIEVING CARDIOVASCULAR AND PULMONARY HEALTH**

Over the past 25 years, the United States has experienced a steady decline in the age-adjusted death toll from cardiovascular disease (CVD), primarily in mortality from coronary heart disease and stroke. Despite this decline, coronary heart disease remains the leading cause of death and stroke the third leading cause of death (8). Lifestyle improvements by the American public and better control of the risk factors for heart disease and stroke have been major factors in this decline. Coronary heart disease and stroke have many causes. Modifiable risk factors include smoking, high blood pressure, hypercholesterolemia, obesity, diabetes, and physical inactivity. In contrast to the positive national trends observed with cigarette smoking, high blood pressure, and high blood cholesterol, obesity and physical inactivity in the United States have not improved. People with disabilities share these traits with the general population.

Physical inactivity is common in all demographic groups but, on the basis of current knowledge, it appears to occur disproportionately among people with disabilities, people who are not well educated, and people who are socially or economically disadvantaged. As adults age, their physical activity levels continue to decline. Besides the cardiovascular system, physical inactivity is also associated with such other adverse health effects as osteoporosis, diabetes, and some cancers. Activity that reduces CVD risk factors and confers many other health benefits does not require a structured or vigorous exercise program. The majority of benefits can be gained from moderate-intensity activities, which are more likely to be continued than high-intensity activities (9). Physical activity protects against the development of CVD and also favorably modifies other CVD risk factors including high blood pressure, blood lipid levels, insulin resistance, and obesity (10). However, questions remain about the type, frequency, and intensity of physical activity needed to prevent and treat CVD and about the risks, benefits, and costs associated with becoming physically active. The development of muscular strength and joint flexibility also is important as it improves the ability to do occupational and recreational tasks and reduces the potential for injury. In particular, people with disabilities may benefit from flexibility and resistance training to improve the ability to do activities of daily living (11).

Because of the large reserve in normal lungs, pulmonary function does not generally limit physical activity or exercise performance (12). However, in many individuals with otherwise normal lungs (up to 20-30 percent of the general population), exercise may be associated with bronchospasm that reduces airflow. If severe enough, this exercise-induced bronchospasm can produce clinical symptoms of breathlessness (dyspnea) or coughing that can limit physical activity. The association of bronchospasm with clinical symptoms is recognized as asthma. As a clinical entity, asthma is present in 4-8 percent of the population.

The key to management of disability due to impaired pulmonary function is recognition and appropriate preventive strategies. General control measures include gradual warm-up and cool-down; intermittent exercise; nasal breathing; and paying attention to the environment to avoid cold or dry air, allergens, or irritants. For those with frequent or regular symptoms, good control of the underlying asthma is important. Drug therapy should emphasize regular anti-inflammatory medication with inhaled corticosteroids supplemented with inhaled beta-2 sympathomimetics. Cromolyn may be particularly useful in preventing exercise-induced bronchospasm. It is important for everyone involved in physical activity, including participants, coaches, and rehabilitation professionals, to recognize the possibility of exercise-induced asthma as a potential cause of exertional breathlessness.

Chronic lung diseases typically present at advanced stages of illness associated with significant functional limitation and disability. In such individuals, physical activity may be associated with disabling symptoms of breathlessness that cause progressive inactivity due to the physical symptoms as well as associated fear and anxiety. Exercise training for persons with chronic lung disease has been shown to produce significant physical and psychological health benefits. Most studies have been performed in subjects with chronic obstructive pulmonary disease (COPD), the most common chronic lung disease. In those with COPD, exercise is important in maintaining general conditioning and improving levels of physical activity important for activities of daily living. It is also an excellent means of helping people learn to cope with and control the dyspnea and fear associated with exercise. Upper limb exercise is particularly problematic for persons with pulmonary disorders; even relatively simple daily care activities that involve using the arms against gravity, such as brushing the hair or teeth or putting on a shirt, may be associated with intense symptoms of breathlessness. Consequently, in view of the principle of training specificity, physical training programs for such people should incorporate upper limb exercise.

There is evidence that a significant proportion of the population of people with disabilities possesses a greater than average risk of acquiring cardiovascular disease. Sawka et al. studied the wheelchair exercise performance of young, middle-aged, and elderly subjects and reported that many middle-aged and elderly subjects demonstrated abnormal signs or symptoms that were suggestive of cardiovascular disease (13). Of the total population interviewed by these investigators, 56 percent were excluded because of suspected cardiovascular disease. Kavanagh and Shephard reported a similar finding when researching the application of exercise testing in elderly people (N=62) with lower limb amputations, of whom 48 percent had indications of cardiovascular disease (14). The authors of a Department of Veterans Affairs Report have speculated that the sedentary lifestyle adopted by many people with traumatic amputations may be an important factor in their high mortality rate from CVD disease (15). Studies have also shown that people with mental retardation have lower cardiorespiratory capacity than the general

population (16).

Graded exercise stress tests are commonly used to determine fitness levels commensurate with health and functional status in people with physical disabilities (17). However, many people with disabilities are incapable of performing lower limbs exercise tests that are widely used in the diagnosis of coronary heart disease (18). Dynamic arm exercise testing (e.g., arm crank or wheelchair ergometry) provides a reproducible, noninvasive method of evaluating cardiovascular function in people who are unable to perform leg-cycle ergometer exercise owing to neurologic, vascular, or orthopedic limitations (19). Such individuals may include those with intermittent claudication, disabling arthritis, or paraplegia (20). In addition, arm ergometry appears to be the functional evaluation of choice for persons whose occupational and recreational physical activity is dominated by upper limb efforts, since leg exercise testing suboptimally predicts arm performance capacity, and vice versa (21-25).

Arm-crank ergometry has been shown to offer a comparable (22,26) or slightly less sensitive (27) alternative to leg exercise testing for the detection of ischemic ST segment depression, the provocation of angina pectoris, or both. The reduced sensitivity of upper body testing may be attributed, at least in part, to the fact that maximal heart rate and systolic blood pressure are generally greater during leg exercise than during arm exercise (28). As a result, the maximal rate-pressure product and myocardial oxygen demand may be lower during arm cranking. However, arm exercise coupled with thallous (thallium) chloride  $^{201}$  scintigraphy has been shown to be an effective method of detecting myocardial ischemia and assessing prognosis in persons at increased risk for coronary artery disease (29).

Equipment suitable for arm exercise testing includes wheelchair or arm-cycle ergometers. Although a comparison of the physiologic responses to wheelchair and arm crank ergometry revealed a significantly lower physical work capacity and maximal heart rate for the former, maximal oxygen consumption was comparable for both exercise modes (30). Since both types of ergometry yielded similar maximal oxygen consumption values, it was concluded that clinical exercise testing using arm crank ergometry would probably provide a valid estimate of an individual's aerobic potential for wheelchair type activity. This has been substantiated by the high correlation ( $r=0.84$ ) between maximal oxygen consumption values during arm cranking and a propulsion distance field test in male wheelchair users (31). Newer techniques are being developed for the detection of coronary artery disease that use a computer controlled wheelchair ergometer and digital exercise echocardiography.

For many people with disabilities, arm exercise is associated with deficient peripheral and central hemodynamic responses due to inactivity of the skeletal muscle pump. Several studies have shown that arm work performance, metabolic and cardiopulmonary responses, and aerobic training capability may be improved by reducing blood pooling and stasis in the legs, thereby enhancing venous return and cardiac output. For some people with central nervous system impairments, this can be accomplished by using a multichannel functional electrical stimulation (FES) device to induce rhythmic isometric contractions of the calf and thigh muscles to activate the skeletal muscle pump during arm cranking exercise and wheelchair locomotion.<sup>32</sup> These contractions may also contribute to the integrity of the muscles activated. However, to markedly improve performance of paralyzed muscles for FES use, it is essential to use a training protocol

that incorporates dynamic contractions through a specific range of motion and the principle of "progressive overload." Use of computerized FES-induced leg cycle ergometer exercise can improve both muscular performance and cardiopulmonary fitness. This may be due to the muscles employed (e.g., quadriceps, hamstrings, gluteus maximus) with cycling and the higher frequency at which they are stimulated to contract (e.g., 50/min). As opposed to arm exercise, the enhanced volume loading of the heart and greater cardiac output with FES leg cycling is desirable for aerobic training. Moreover, increasing evidence suggests that using FES techniques for inducing exercise in the paralyzed lower limb muscles can enhance the health and fitness of individuals with spinal cord injury (SCI), and contribute to their rehabilitation potential (33). This is particularly true for individuals with tetraplegia who have limited exercise options (34).

### *Recommended Research*

1. Determine the frequency and intensity of exercise commensurate with good health for people with disabilities.
2. Quantify energy expenditures for various activities performed by people with disabilities.
3. Investigate cardiovascular and pulmonary function of women with physical disabilities.
4. Explain the impact of incorporating FES with other techniques for rehabilitation.
5. Identify examples of moderate physical activity/exercise for people with disabilities.
6. Study upper arm strength in people with chronic lung disease.

## **HEALTH AND NUTRITION**

In the United States, government guidelines outline optimal daily levels of nutrients needed by the average individual. There are also normative standards of weight per height, as relative fitness recommendations, for the general population (35). The intensity, frequency, duration, and type of daily exercise a person does affects his/her body composition as well as his/her dietary needs. Maintenance of good health requires balancing these factors and striving for the appropriate combination, for each individual, relative to gender, age, lifestyle, values, and religious beliefs.

For people with disabilities, nutrient requirements should be evaluated relative to differences in activity levels, altered metabolic processes, chronic medications, and varied modes of eating (36,37). Body weight per height for people with disabilities may need adjustment from the usual guidelines, by evaluation relative to body composition (examples of varying body types include people with tetraplegia, or people missing a limb) (38). The mode of ambulation or inability to move greatly affects energy needs as well as body weight. Long-term body composition and nutrient needs change over time. Therefore, periodic evaluation of the nutritional status of the individual by a healthcare professional is useful to identify deficiencies before they become problematic. Most people with disabilities know they should be eating less fat, eating more fruits and vegetables, and exercising regularly. Yet, less than 20 percent of the general population eats the minimum number of 5 daily servings of fruits and vegetables, and an equally small number of people exercise regularly (39).



Food choices made by people with disabilities may also be affected by their physical limitations. For example, persons with poor manual dexterity or those with an upper limb amputation may avoid preparing foods that require chopping or peeling. A person in a wheelchair may have difficulty cooking because the counters and stovetops are too high (40). Someone with a visual impairment may have difficulty reading cookbooks. High fat, high sodium, low fiber convenience foods, and fast foods are often consumed by people who have difficulty cooking. These barriers can prevent people with disabilities from making regular healthy food choices.

A number of barriers may also prevent people with disabilities from engaging in regular physical activity. These include poor accessibility of fitness facilities, lack of transportation to a facility, cost, and feelings of insecurity. Some people with disabilities may also require physical assistance with exercise equipment or the exercise itself. Long-term exercise participation is unlikely, unless a person is motivated and has the desire to change. Once a person has developed the motivation and readiness to change, the next step is to examine the factors that have prevented them from eating healthy food and exercising regularly (41). When evaluating nutrition, clinicians and people with disabilities should consider the amount and type of food and fluid consumed, and the rate at which food and fluid are metabolized. Considering these factors can provide a fairly accurate assessment of one's health as it relates to nutrition.

### *Recommended Research*

1. Investigate the impact of peers, scientists, and clinicians in promoting appropriate nutrition and physical activity among people with disabilities to fight against the secondary effects (e.g., chronic disease) that are associated with a sedentary lifestyle.
2. Develop appropriate weight and body mass index tables for both children and adults with disabilities.
3. Determine appropriate fluid intake for people with disabilities.
4. Develop guidelines for proper nutrient intake and exercise for people with disabilities, including the interaction between these two modalities.

## **PHYSICAL ACTIVITY AND CHILDREN WITH DISABILITIES**

Much of what is known about the effects of exercise has been learned in adults. Although research is progressing in the area of exercise in children, the physiologic, psychosocial, and medical effects are still not well defined (42). These aspects of physical activity are even less understood in children with disabilities (43). Because of the great diversity of disabling conditions, it is difficult to generalize information that has been gathered on the general population of children (or even research on other disabilities) to a specific child or group of children. A spectrum of ability and limitation exists within a disability "category" that precludes a standardized experimentally based examination of children and disabilities. Therefore, the caveat of the tenuous extrapolation of adult to children's data is even greater when applied to children with disabilities. Any attempt to investigate the effect of exercise on children with disabilities must evaluate the effect of the disability on normal physical and psychosocial growth and

development (44).

Affecting approximately 10 percent of the children between the ages of 4-17, chronic health disorders are defined as any condition that lasts at least 3 months in a given year (45). Disabilities can be categorized into those with physical impairments, sensory impairments, and cognitive impairments. Obviously, there is much overlap among these categories in many disabling conditions. As opposed to other children's sports activities, most programs for children with disabilities must be individualized because of these unique differences.

The goals of sports participation and exercise may need to be individualized but can include similar categories: health improvement via cardiopulmonary conditioning, altered body by decreasing obesity (e.g., increasing lean muscle mass and decreasing adipose tissue), increased muscle strength and endurance, and enhanced flexibility. Other equally important benefits of sports and exercise include the development of self-esteem, social integration, and the learning of social and team skills (43).

The following questions must be answered prior to the development of a sports or exercise program for an individual, for the "disability" and for the sports community:

- What are their cognitive abilities, what are their social skills?
- What effect does the disability or treatment have on stamina and skills?
- Will specific sports activities pose a substantial risk to health and well being?
- Will specific interventions or modifications and conditioning or preparation be required?
- How could an activity be modified to allow a child to obtain maximal benefit?
- What level of activity would be best for this particular child?

Limited data suggest that the energy cost of movement in children with neuromuscular disease (NMD) is inflated compared with values for unimpaired controls (46,47). This disability imposes a greater relative stress on the cardiovascular system and leads to early fatigue during locomotion. Understanding the factors that contribute to higher transport costs in children with NMD, and the extent to which ambulatory energy demands can be reduced in this cohort, may aid in the formulation and evaluation of rehabilitative modalities directed toward improving functional mobility in physically challenged children. Moreover, such information may prompt the early intervention of health professionals in implementing and assessing the efficacy of specific treatment strategies.

A disability that may prevent or limit one's involvement in certain activities can be extremely frustrating for the individual affected. For adults, a disability can be effectively managed through a process of acceptance, rehabilitation, and the desire to maximize their unimpaired capacities. For children, however, a disability can have dire consequences, since the activities that the typical child would have enjoyed are crucial for the development of skills such as physical coordination, cognition, and communication. Depending upon the disability, these skills have been developed by the adult, thus making it is easier for the adult to cope with a disability and allow him or her to become their own advocate (34). However, without these skills being present in some children, the onus of responsibilities fall to the family, friends, and/or clinicians. What is typically done in

these circumstances is to rapidly initiate a program that includes standard rehabilitation practices, education of family and friends, and making most activities (albeit modified) that unimpaired children enjoy accessible to the child with a disability. Making activities accessible is often referred to as social inclusion or mainstreaming and is given high priority by healthcare providers, government agencies, and advocacy groups.

Activities in which a child typically participates can be classified as being education, play, social, or work related. A multidisciplinary effort by educators, therapists, engineers, and others has helped to make such activities possible for the child with a disability. The methods used vary widely from initiating new policy to developing both low and high technology solutions to the problem. Policy examples include the Americans with Disabilities Act (in the United States) and an increase in available research funding (40). Examples of low technology solutions include toys and other devices adapted for ease of use by the child. High technology solutions include mobility aids, augmentative and assistive communication devices, and computer interfaces.

### *Recommended Research*

1. Develop safe and effective exercise training programs for children with disabilities.
2. Explain the effect of acute and chronic exercise on the metabolism of medications used by people with disabilities.
3. Describe the physical and psychological effects of physical activity on children with disabilities.
4. Clarify the influence of physical activity on disability during human development.
5. Describe the influence of growth on locomotion efficiency.
6. Describe the effects of physical activity on the health of people with disabilities and chronic diseases.

## **DISCUSSION**

It is uncertain whether or not people with disabilities respond differently to exercise. The most information is known about cardiac disease (i.e., a significant physical impairment), which presents a paradigm to work through a variety of disabilities. As intensity of activity is increased in the healthy individual, oxygen consumption increases linearly, peaks, then levels off as work is further increased (48,49). To achieve optimal aerobic conditioning, the American College of Sports Medicine recommends a progressive exercise program for healthy persons that evokes a sustained heart rate of 60-90 percent of the individual's maximal heart rate for 20 to 60 continuous or accumulated minutes at least 3 times a week (50). The maximum oxygen consumption that can be achieved by people with heart disease is commonly 30-50 percent below their age and gender-matched counterparts without heart disease (51,52). Moreover, considerable evidence suggests that the threshold intensity for training increases in direct proportion to the maximal oxygen consumption level or the level of habitual activity (53). Thus, intensity must be lowered and progression adjusted. Risk stratification is imperative, since people at high-risk following an acute myocardial infarction may require monitoring and supervision of the basic protocol as activity is

increased. If cerebral palsy or other physically disabling co-morbid conditions are present, further modifications in the equipment or mode of exercises may be required to account for the increased energy required to accomplish basic activities resulting from neuromuscular or musculoskeletal disabilities.

With disabilities of the neurological or musculoskeletal systems, the potential benefits and harm to tendon, muscle, or bone must be considered. Disuse can lead to osteoporosis, fracture, and/or soft tissue contractures (54-56). Because of disuse osteoporosis, one-sixth of all people with spinal cord injury fractures the tibia or femur, generally during transfers (57). Overuse can cause stress fractures or cumulative trauma disorders. Manual wheelchair users are particularly susceptible to rotator cuff tears, lateral epicondylitis, and cubital tunnel or carpal tunnel neuropathies due to micro-injury caused by the repetitive motions required to propel themselves (55,58,59). When wheelchair use is the primary mode of mobility, it may be difficult to provide sufficient rest to allow complete healing. This can eventually lead to fibrocartilage metaplasia and calcific tendinitis (60,61). The level of physical activity required to augment cardiovascular fitness may induce excess amounts and frequencies of loading on musculoskeletal tissues (60). Theoretically, there is an activity window that lies between complete disuse and maximum vigor that will provide the benefits of loading, muscular contractions, and cardiac conditioning without the detrimental affects of overuse (59,61). An understanding of the biomechanical determinants of this window for various congenital or acquired states of illness or injury must provide the foundation for any exercise recommendations provided to persons with disabilities (62).

In addition to distinct problems in musculoskeletal and neurological function, people with disabilities as a group have lower incomes than the national average, less energy, and more problems with transportation than persons without disabilities, thus creating a greater number of barriers to exercise. One of the primary constraints noted by people with disabilities is a lack of information related to their disabilities (63). Lack of time is not commonly cited as a barrier, as is often the case for unimpaired people. We conclude with some general principles with regard to recommending exercise programs to people with disabilities.

### *Recommendations for Improving Health Among People with Disabilities*

1. Acknowledge that one of the most important factors in stimulating involvement in regular physical activity is the referring physician's recommendation (64). Recommendations should be specific and focus on the health/fitness goals of the individual and concomitant risk factors. Recognize that transportation to a suitable exercise facility may represent a major barrier, and that home exercise rehabilitation should be investigated as a viable alternative, because of its lessor cost, convenience, and potential to promote greater independence (65).
2. Health professionals should evaluate joint integrity, degree and areas of paralysis or spasticity, and cardiac status. Clinical findings in these areas will affect the mode, intensity, frequency, and duration of activities recommended. Exercise strategies that protect any compromised joints and encourage muscle balance between the antagonistic and protagonistic muscle groups should be developed. Arm ergometry and resistive training may be substituted for lower limb weight-bearing activities. In some cases, lack of regular orthostatic stress may be even more detrimental than physical inactivity,

highlighting the need for weight-bearing activities, even if adaptive equipment is required (66-68).

3. If an individual is unable to tolerate the optimal aerobic intensity for cardiopulmonary reconditioning, a longer duration, more frequent sessions, or both, should be recommended. Lower intensity training levels can provide health benefits, and the least fit show the greatest magnitude of improvement (69).
4. Establish short-term goals, promote positive reinforcement through periodic feedback of results, document individual achievements on progress charts, and compare an individual's achievements to past status rather than to established norms (33,60). Make it fun; develop modified recreational games for persons with specific types of disabilities to maximize safety and success; and, recruit the support of family members.
5. Develop progressive programs that are sufficiently practical, accessible, and compatible with the individual's life-style, so that exercise will be continued on a long-term basis. Teach persons with disabilities about the importance of alternating rest and activity to minimize fatigue and maximize conditioning benefits. Ensure that the individual is receiving proper nutrition. Seek the optimal format of conditioning.

The ability to exercise and maintain health differs substantially among people with disabilities and the general population. The development of accessible exercise programs and graded exercise test protocols that are targeted toward people with disabilities are important in the fight to control the disproportionate incidence of morbidity and mortality from cardiovascular disease within this subpopulation. Improved assessment procedures would provide (*a*) baseline data for determining the effectiveness of physical conditioning programs, (*b*) data for assessing the outcomes associated with rehabilitation programs, (*c*) a means to track the progressive deterioration of health resulting from the inactivity imposed by impairment and disability (*d*) a non-invasive, less costly method for the diagnosis of coronary artery disease for people who are unable to adhere to current standardized protocols, and (*e*) influence of diet and exercise in controlling risk factors.

The metabolic, hemodynamic, and psychophysical aspects of exercise have been well researched. However, the development of assessment procedures specific to the needs of persons with disabilities has not progressed to the point where there is a commonly accepted paradigm for clinical practice comparable to the Naughton (70) or Bruce (71) treadmill protocols. Regardless of the many problems associated with standardization of field tests for the measurement of cardiopulmonary fitness, there remains the need to develop viable assessment protocols for use in medical, school, community, and population studies. Work should continue on the development of cardiopulmonary fitness norms in people with disabilities. It is unlikely that any one laboratory will have access to a sufficiently large heterogeneous population of males and females with disabilities to accomplish this work alone. However, there are a number of researchers throughout the world who have already collected substantial demographic, metabolic, and hemodynamic data during submaximal and maximal exercise among people with disabilities. With greater collaboration, after several years, a database could be available to all participants for analysis with the goal to develop normative standards for cardiopulmonary fitness among people with disabilities. In addition, such a database could be used to determine expected values for selected physiological measurements that may be based on age, gender, height, weight, and body composition, as already exists for the unimpaired population. For example, "functional aerobic impairment" could be determined if it were possible to predict the aerobic power of an individual

with a disability. Finally, additional research regarding cardiopulmonary assessment of women, minorities, and older people with disabilities is sorely needed.

Health benefits from physical activity and proper nutrition appear to be similar among diverse population subgroups. However, behavioral and attitudinal factors that influence the motivation for and ability to sustain physical activity and proper nutrition are strongly determined by social experiences, cultural background, physical disability, and health status. Healthcare providers have a key role in other risk reduction behaviors and seem to be an important influence in the adoption of regular physical activity and proper diet (72). Intervention methods should be documented and scientifically proven. Family and friends, work sites, and schools are also important contributors.

## CONCLUSION

Greater emphasis must be placed on determining the risks and benefits of exercise among people with disabilities. Exercise must be studied from the perspective of disease prevention while mitigating risk for injury or degeneration. Five areas were identified as focal points for future research: epidemiological studies; effects of nutrition on health and ability to exercise; cardiovascular and pulmonary health; children with disabilities; and accessibility and safety of exercise programs. As people with disabilities live longer, the need for addressing long-term health issues and risk for secondary disability must receive greater attention. Research studies must be expanded to include people from a broad array of disability etiologies. The consensus process resulted in several specific examples of the areas of exercise and health promoting activities that need further study.

## APPENDIX

**Panelists:** J. Stuart Krause, PhD, Shepard Spinal Center; Edmund Y.S. Chao, PhD, Johns Hopkins University; Peter W. Axelson, MS, ME, Beneficial Designs, Inc.; Michael Alexander, MD, Alfred I. Dupont Institute; John Bach, MD, University of Medicine and Dentistry of New Jersey; Rory A. Cooper, PhD, University of Pittsburgh-VA Pittsburgh Healthcare System; Henry Chambers, MD, University of California at San Diego; Margaret Stineman, MD, University of Pennsylvania; Patricia Painter, PhD, Stanford University.

**Experts:** Steven Blair, PED, Cooper Institute for Aerobic Research; Mitchell LaPlante, PhD, University of California at San Francisco; Michael Ferrara, PhD, Ball State University; Linda Kautz Osterkamp, PhD, Southern Rehabilitation Hospital; Bernadette Marriott, PhD, National Institutes of Health; Helga Rempel, RD, MSc, Consultant-Athlete; Russel V. Luepker, MD, University of Minnesota; Andrew Ries, MD, University of California at San Diego; W. Edwin Langbein, PhD, Edward Hines Jr. VA Hospital; Roger Glaser, PhD, Wright State University; Henry Chambers, MD, University of California at San Diego; Oded Bar-Or, MD, McMaster University; Don W. Morgan, PhD, University of North Carolina at Greensboro; Kirk Reinbold,

PhD, University of Pennsylvania; J. Larry Durstine, PhD, University of South Carolina; Kai-Nan An, PhD, Mayo Clinic-Rochester; James Rimmer, PhD, Northern Illinois University; Barry Franklin, PhD, Wayne State University.

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