International Journal of Applied and Natural Sciences (IJANS)
ISSN (P): 2319–4014; ISSN (E): 2319–4022
Vol. 9, Issue 5, Jul–Dec 2020; 89–100

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

SPORT FOR ALL IN HEALTH AND DISEASE

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ABSTRACT

Increasing evidence suggests that exercise can benefit many health conditions through prevention, treatment, or rehabilitation. The most specific and pronounced effects take place in the neuromuscular and musculoskeletal structures and functions, and they are primary and unique in their nature. The characteristics of exercise and physical activity needed for these effects are rather well known. Exercise is as equally important for the sick and disabled as it is for the healthy. The spectrum of the health benefits of exercise is broad, many benefits are of major practical significance, and adaptive capacity is retained through old age. Furthermore, exercise meets many criteria of wide applicability for population-oriented promotion. There are health risks in exercise but proper guidance and prescription warrants safe participation. In order to make use of the health potential of exercise, intensified product development of "exercopea" is necessary via basic and applied research.

KEYWORDS: *Exercise, Feasibility, Fitness, Health Promotion, Health Risk, Physical Activity, Prescription, Prevention, Rehabilitation*

Article History

Received: *19 Oct 2020* **|** ***Revised:*** *04 Nov 2020* **|** ***Accepted:*** *30 Nov 2020*

INTRODUCTION

More than 2000 years ago the Greek physician Hippocrates claimed that exercise is necessary for health: "All parts of the body which have a function, if used in moderation and exercised in labors in which each is accustomed, become thereby healthy, well developed and age more slowly; but if unused and left idle they become liable to disease, defective in growth and age quickly" [1]. Lately it has been stated equally confidently that, if exercise could be packed into a pill, it would be the single most widely described and beneficial medicine available. How much support does reliable research lend to these views? Can the eventual benefits be gained from exercise that fulfills the criteria of sport for all, from exercise which is feasible, attractive, and safe for the population at large?

Health Effects of Exercise

The list of proved biological effects of exercise is long [2]. Many of these effects, like the increase in high-density lipoprotein and the decrease in blood pressure, are obvious. But are, for example, the effects of exercise on physical fitness or body composition health effects?

Health is a life-long characteristic of all living organisms. It is the individual potential for life and the energy for survival, for growth, development and reproduction, and for the performance of necessary activities and the achievement of certain goals. Health means resistant structures, large functional capacities, and efficient, economic and undisturbed physiological and psychological functioning at rest and under stress.

According to this definition, neuromuscular and cardio respiratory performance capacity, bone mineral content, and the amount and distribution of body fat are, for example, components of health. Caspersen *et al* [3] have divided physical fitness into health-related fitness (including cardio respiratory and muscular endurance, muscular strength, body composition and flexibility) and skill-related fitness (including agility, balance, coordination, speed, power and reaction time). However, some components of skill-related fitness are also closely related to health. Thus, for example, good balance and coordination are important for steady gait and, therefore, for the prevention of osteoporotic fractures.

Thus many effects of physical fitness can be considered health effects. This fact often goes unnoticed because of the large functional reserves of young and even middle-aged people and because of people's tendency to emphasize problems or deficiencies (ie, diseases) when speaking about health.

Table 1 shows provide a list of ways in which exercise is claimed or hypothesized to affect various health conditions beneficially. Is this long list at all well founded, or is exercise offered uncritically as a panacea? Supporting evidence and plausible hypotheses for the claimed effects can be found in the references cited in Table 1. However, in only some cases is the evidence currently strong enough to justify firm conclusions and the recommendation of exercise for specific purposes. Table 2 gives some examples of the degree of certainty of the evidence for the use of exercise in primary prevention. Even this list can be debated. Thus the role of exercise, for example, in the prevention of postmenopausal osteoporosis, seems very probable [11], but there is uncertainty about the magnitude and persistence of the long-term effects of exercise on bone and about the characteristics of the exercise necessary to stimulate bone formation or to decrease proneness to falls [11].

Table 1: Ways in Which Physical Exercise Has Been Claimed or Hypothesized to Affect Various Health Conditions Beneficially

	Reference
Prevention and rehabilitation of primary and secondary musculoskeletal disorders in aging and in chrome diseases	4,5,6
Prevention and treatment of neck and back pain	7,8
Prevention and treatment of primary and secondary joint deterioration and dysfunction	9,10,11
Treatment and rehabilitation of rheumatoid arthritis	12
Prevention of postmenopausal and senile osteoporoses and osteoporotic fractures	11
Prevention, treatment and rehabilitation of adiposity	13,14
Rehabilitation of chronic airway obstruction	15,16
Prevention and treatment of cardio respiratory deterioration in aging and in chronic diseases	5,17
Prevention and rehabilitation of coronary heart disease	13,18,19
Rehabilitation of cardiac failure	20
Rehabilitation of peripheral arterial disease	21
Prevention and treatment of hypertension	22,23
Treatment of neurocirculatory asthenia	24
Treatment and rehabilitation of diabetes	25
Prevention and treatment of constipation	26
Prevention of colon cancer	27,28

Table 1 Contd.,

Prevention of breast and uterus cancer	29,30
Alleviation of dysmenorrhea	31
Alleviation of depressive mood, anxiety and tension, relief of stress	32,33,34,35
Improvement of sleep	36

Table 2: Degree of Evidence to Support Recommendations for Physical Exercise in the Primary Prevention of Certain Health Conditions [37]

Condition	Degree of Evidence
Coronary heart disease	
Adult men	Good
Adult women	Poor
Hypertension (all adults)	Good
Noninsulin-dependent diabetes (all adults)	Poor
Osteoporosis, bone loss	
Postmenopausal women	Good
Premenopausal women	Poor
Osteoporosis, fractures (postmenopausal women)	Poor
Obesity (all adults)	Good
Mental health (all adults)	
Affect	Poor
Self-esteem	Fair

Basis for the Multitude of Health Effects of Exercise

The basic elements of exercise, movements, take place in a "kinetic chain" consisting of neuromuscular and musculoskeletal structures and functions. Continuation of the activity requires service of this chain, for example, energy supply and maintenance of homeostasis of the internal milieu. Thus long-lasting and intense exercise activates most of the service and regulatory systems of the body to various degrees. The oxygen transporting system is loaded heavily in certain types of exercises, whereas, for example, kidney and bowel functions are much less affected by any exercise. Some health-related effects of exercise are achieved through immediate or delayed and partly summative responses of one bout or repeated bouts of exercise [23, 38], but most health effects are adaptations to exercise repeated at sufficient frequency, intensity, and duration.

The most specific, and also the most pronounced, effects of exercise, like the changes in muscle tissue and in its metabolism and functions, take place in the kinetic chain itself. These changes can be considered the primary and often unique effects of exercise. The characteristics of the exercise programs producing them are known rather well, as are the individual and environmental factors modifying these effects [39]. On the other hand, the knowledge concerning the effects of exercise on neural structures and functions is still scarce [40]. Many of the acute responses and adaptive changes in the organs serving the kinetic chain, for example, those in the cardiovascular and respiratory organs, are also well known [41], as are the exercise programs causing these effects in predictable, effective and safe ways [42]. However, many potentially important effects of exercise on health still need extensive investigation [43].

Psychological Effects of Exercise

Exercise is claimed to have numerous favorable and unfavorable effects on mental well-being [44]. Because these effects are subjectively experienced, their verification is difficult. This problem is increased by the great influence of situational and motivational factors and expectations. Evidence is strongest to support the beneficial influence of exercise on depressive mood, muscular tension, and anxiety [33-35]. The numerous hypotheses presented to explain the psychological

effects of exercise have so far gained only a limited amount of scientifically valid support [33-35].

Indirect Effects of Exercise

Exercise is commonly believed to be beneficial to health also indirectly by influencing other living habits. There is indeed some evidence from cross-sectional studies that regular exercisers smoke less, drink less, eat less fat, and maintain better weight control than non exercisers. However, the correlations are weak and not consistent in all studies [45,46]. Furthermore, there is only limited evidence supporting the idea that increased exercise causes or is followed by other healthier living habits [46]. Thus the somewhat healthier life-style of the exercisers probably indicates that they are a selected, health-conscious, and self-disciplined subgroup of the general population. However, it may be possible that, in the long run, the adoption of exercise can also influence other living habits, as evidenced by the study of my colleagues and I, in which smoking cessation was significantly more frequent among men who increased their exercise during 5 years of follow-up than among those who maintained or decreased their exercise [47].

Health Effects of Exercise in Diseases

Diseases destroy and diminish health through specific pathological processes like rheumatic inflammation or cardiac insufficiency, but primarily the mechanisms are nonspecific. The symptoms and impairment of functions caused by the disease lead to decreased performance capacity, and this decrease in turn leads to decreased independent activities, impaired coping with daily life, and increased dependency on others. These changes lead further to lowered self-esteem and depressive mood. The secondary effects of the disease thus form a worsening disability circle. At each step there is a tendency towards decreasing physical and other activity for physical, psychological, social/and economical reasons. Exercise may influence the remaining health of a sick person via effects on the specific pathological processes or their direct consequences as, for example, in coronary heart disease [18] and osteoporosis [11,48], but most often and most importantly via physiological and psychological effects on the different steps in the disability circle.

These types of effects are seen as the results of rehabilitation programs of patients with, for example, cardiac diseases [18], rheumatic diseases [12], and back pain [8]. Thus exercise is at least as important for the sick and disabled as it is for the healthy. However, undue optimism should be cautioned against. For example, critical examination of the published results reveals that the psychological benefits of cardiac rehabilitation may be less than generally believed [19].

Sport for All - Significant Potential for Health Enhancement

The spectrum of the health benefits of exercise is broad. Many of these effects can be gained by alternative means such as drugs or diet, but, for example, many of the effects on physical fitness and performance capacity are unique to exercise. Thus, Hippocrates' view has gained much scientific support.

In some cases exercise may have advantages compared with, for example, drug treatment because of its multiple beneficial effects and few side-effects. Thus Kelemen *et al* [49] showed, in a randomized clinical trial, that exercise and a beta-blocking and a calcium-blocking drug decreased the blood pressure of mildly - hypertensive patients to the same degree. But exercise did not have negative effects on blood lipids like one of the drugs, and it also caused a significant increase in physical fitness.

Many of the health effects of exercise are sufficiently large to be of practical significance. Thus moderate aerobic exercise like continuous jogging or brisk walking 20-60 min at a time 3-5 times a week [50] increases maximal aerobic power by an average of 15-20% and aerobic endurance capacity even much more [41]. In the same way, 8 to 12 repetitions of

resistance exercises loading the muscles to near fatigue at least two times a week increases the strength of trained muscles by 20-30% in about 6 months [50]. These gains are very significant considering, for example, the aging effects, about a 9% decrease in aerobic power per decade in sedentary adults [50] and about a 20% decrease in muscle strength between 50 and 65 years of age and further decline thereafter [5]. The adaptive capacity to counteract many harmful effects of aging through physical activity is retained to old age, as shown by the increased^ or maintained cardio respiratory fitness in persons over 70 years of age [51], increased muscle strength and mass in persons over 90 years of age [52], and maintained or even slightly increased bone mineral density-in persons over 80 years of age [48] following exercise training.

Exercise has significant effects also on, for example, risk factors of coronary heart disease. Thus, regular aerobic exercise causes a decrease in systolic and diastolic pressure, an average of about 10 mm Hg (=120 Pa) [22], a 5-16% increase in high-density lipoprotein in most studies, a decrease in elevated triglyceride concentration [53], a decrease in plasma insulin [25], and a decrease in platelet aggregability [54]. Many of these and other beneficial effects of exercise are associated with weight loss and the prevention of weight gain. On the whole, improved weight control can be considered one of the most important health effects of exercise.

The cumulative evidence suggests more and more strongly that regular aerobic exercise [18,55-60] and/or physical fitness [18,61] is a significant protective factor against coronary heart disease or, conversely, physical inactivity is a risk factor of about the same power as moderately high serum cholesterol or blood pressure or moderately heavy smoking [55]. Until recently exercise was considered only a minor risk factor. Powell *et al* [55] concluded that, in prevention programs for coronary heart disease, exercise should be promoted as vigorously as blood pressure control, dietary modification, and smoking cessation. The most recent studies mentioned support this conclusion.

Some of the psychological effects of exercise are also of sufficient degree to be of practical value. Thus the results of a meta-analysis of the antidepressant effects of exercise suggests that exercise is as effective in decreasing depression as is psychotherapy, and this effect is seen in a large variety of subjects and has been brought about by various feasible exercise programs [35].

Feasibility of Exercise

Exercise not only has to be effective, but also feasible before it can serve as an efficient public health measure. At least in principle exercise meets the criteria of large applicability. Most health effects are brought about by rather simple, commonly practiced activities like walking, jogging, running, cycling, cross-country skiing, and swimming. The effectiveness of exercise is determined more by its relative than absolute amount and intensity. Thus in terms of important health effects running in the twenties corresponds roughly to jogging in the thirties and forties, to fast walking in the fifties, and to brisk walking in the sixties. Already moderate exercise brings significant health benefits, and beyond a certain level the additional benefits tend to decrease, when at the same time the “costs” in terms of, for example, time and risks increase [62]. On the other hand, most health effects appear only when certain threshold values are exceeded. This threshold may be lower for unfit than for fit persons even in relative terms [50] and would therefore increase the usefulness of exercise among old and sick people [63].

The key determinant of the feasibility of exercise is the intensity, because strenuous exercise like jogging exceeds the abilities and motivation of most middle-aged, older, and sick people [35,64] and increases the risk of injuries and cardiovascular complications [65]. Currently there are different opinions of the sufficient intensity of exercise, moderate versus vigorous, to attain certain health benefits, for example, a preventive effect on coronary heart disease [57, 60, 61, 66].

Safety of Exercise

The incidence of overuse injuries and traumas in exercise and sports is high [62, 67]. However, the majority, especially traumas, takes place in sports in which speed, strength, power, and skill play an important role and which are practiced more or less competitively. The incidence of overuse injuries is related very clearly to the total amount and also to the intensity, frequency and duration of exercise, as well as to the rate of their changes [68]. Serious cardiovascular complications in exercise are infrequent although not random incidents. The victims are usually sick, although often latently, and the risk is higher in intense than in light or moderate exercise [62, 67]. Thus exercise includes health risks, but, when properly prescribed and guided [62, 68], it can be practiced safely, as evidenced by the vast experience from, for example, cardiac rehabilitation programs [19].

Utilization of the Health Potential of Exercise — need for Product Development

Although most health effects of exercise can be gained through feasible and safe activities which correspond to the motivations of the large majority of people, only a minority of the adult population is currently engaged sufficiently in health-enhancing exercise [69]. Thus possibilities to increase exercise participation in the population should be pursued. It has been estimated that in the United States sedentary life-style is the most prevalent (58%) modifiable risk factor for coronary heart disease [70]. Consequently, it is time to act to make good use of the health potential of exercise [71].

Exercise can be considered one group of the numerous health products on the market. Some of the exercise products can be used as “over-the-counter” remedies, for example, as a “tonic” for general health enhancement without an expert’s advice. Some of the exercise products require individual medical prescription and counseling based on thorough professional evaluation. Exercise for insulin-dependent diabetic patients [25,72], for patients with mild hypertension [23], and for cardiac patients [73] are examples. It is obvious that the more specific the health indications and the more severe the health problems, the more thorough the knowledge needed of the predictability of the effectiveness, efficacy, and safety of the exercise on the individual level.

Currently only some of the exercise products are fully developed. Fitness programs are the best examples of these [50], and they have also been marketed successfully. The same applies to a large extent to cardiac rehabilitation programs [74]. Programs for lipid lowering [53,73] and blood pressure lowering [22,23,76] have already been relatively well developed, but additional data are needed on, for example, the effectiveness, necessary dose, and factors modifying the exercise responses. Similar and even more basic knowledge is needed on many other specific health applications of exercise. A very demanding task is to develop exercise into a thoroughly tested, generally accepted group of products for the prevention of slowly developing degenerative diseases like coronary heart disease and osteoporosis. However, already current knowledge has been considered sufficient to recommend exercise as a preventive factor for these diseases [13, 37, 77, 78], although in many recommendations the measures concerning exercise are still rather approximate and less emphasized than the other measures.

Concluding Remarks

Exercise is a physiological stressor to the body and mind, and it causes numerous responses and adaptations beneficial to health. Some of them are unique and un compensable, while many are complementary to other measures. The general trend is towards a gain in support for the earlier observations and hypotheses on the health benefits of exercise from studies using improved research technology. The evidence supporting the feasibility and safety of the necessary exercise has also increased.

Thus, on the basis of scientific knowledge and practical experience, it is justified to consider exercise, not only as a leisure-time pursuit, but also as an important measure enhancing and protecting the health of the population. The prevalence of various health conditions that can be positively affected by exercise is high in the general population, and also the probability of influencing one or more of these conditions safely through moderate regular exercise is high. However, it is obvious that much more knowledge is needed before exercise can be used for specific purposes. Only when exercise programs or "products" have undergone the scrutiny corresponding to that applied, for example, in drug development [79] can they be marketed on a sound basis. This task is a great challenge for the researchers working in a multitude of areas of both basic and applied sciences, and it calls for intense intra- and interdisciplinary cooperation.

The great challenge is worth tackling. It can be foreseen that for some purposes exercise will not fulfill the optimistic expectations, but most of the present hypotheses will remain valid and the prescriptions will be refined. Exercise will prove to be a beneficial, safe, attractive, and cost-effective physiological health measure also for some new conditions. All this knowledge will be offered for use as an “exercopea” giving detailed knowledge of the use of exercise for different purposes either as “over-the-counter” or as “prescribed” remedies. A substantial part of the “exercopea” has already been written in several thorough and critical statements, reviews, textbooks, and guides.

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