IS PHYSICAL EXERCISE A UNIVERSAL MEDICINE?

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HEALTH AND PHYSICAL ACTIVITY

The relation between health and physical activity is not so clear.

From a physiological point of view, most functions and structures are in one way or another affected by physical exercise. To perform an exercise notably in a steady state the exercising muscles need oxygen and substrates. Many steps are required to transport oxygen from air to the mitochondria and the substrates, essentially glucose and fatty acids, from their proper storage areas to the skeletal muscles. These steps include pulmonary ventilation, pulmonary diffusion capacity, cardiac output, oxygen distribution from blood to mitochondria and oxidizing enzymes. In this oxygen cascade there are a number of factors that limit the aerobic capacity expressed by the maximal oxygen consumption (VO2). This parameter depends on heredity, habitual physical activity and ageing as has been perfectly demonstrated in healthy subjects. Thus physical activity and training are able to stimulate all these functions, the final result being a significant increase in VO2 max. Conversely, physical inactivity results in deconditioning expressed by a significant decrease in VO2 max. Probably the most cited study concerning these points is the Dallas Bedrest and Training Study, published in 1968 (1).

In clinical practice, the perception of physical exercise is more complex. The Hippocratic medical principles, however, were clear: “In a word, all parts of the body which were made for active use, if moderately used and exercised at the labor to which they are habituated, become healthy, increase in bulk, and bear their age well, but when not used, and when left without exercise, they become diseased, their growth is arrested, and they soon become old” (2).

In contrast with these principles and though its popularity and its perceived efficacy have varied greatly over the centuries, bedrest has often been considered a medical treatment for an illness or particular medical conditions. Consequently, for a long time physicians have proscribed any physical activity. For instance, the earliest clinical evidence of the benefits of exercise training in cardiac ischemia was provided in 1802 as a case report by Heberden; but as recently reported by Thompson, it is surprising to observe that exercise training is rarely prescribed for cardiac patients, as evidenced by the fact that only ≈20% of patients who qualify for training are actually referred for formal cardiac rehabilitation programs (3).

Also, it appears more and more significant that inactivity constitutes a major risk factor for chronic diseases including, coronary heart disease, obesity, type 2 diabetes, some cancers, osteoporosis and sarcopenia. This association between the increase in physical inactivity and the appearance of these modern diseases suggests that physical inactivity is an emerging field of biomedical research and also a major candidate for primary prevention strategies. Quantitative estimates indicate that a sedentary lifestyle is responsible for about one-third of deaths due to coronary heart disease, colon cancer and type 2 diabetes. Nevertheless there is a lack of biological and clinical studies able to determine the underlying mechanisms by which physical inactivity promotes disease.

Finally, physical exercise has been considered both a primarily prevention agent and an effective therapeutic agent for only about 15 years. All types of diseases, including rheumatologic diseases and psychiatric disorders may benefit. Thus the question arises: is physical exercise really a universal medicine?

PHYSICAL EXERCISE AS A THERAPEUTIC AGENT

Using the key words “physical exercise”, the number of papers referenced in the Pubmed database is huge, and has been soaring over the last 15 years. When “therapeutic effects” is associated with these key words, it appears that the number of papers selected is drastically reduced, even though the number per year is also increasing (Fig. 1). It is therefore possible to consider that exercise is a dynamic and productive field in biomedical research, but that physicians do not currently considered it a therapeutic agent.

One probable explanation is that we are not able to know the “pharmacology” of this agent. Indeed, if exercise is a therapeutic agent, its prescription should be defined as a

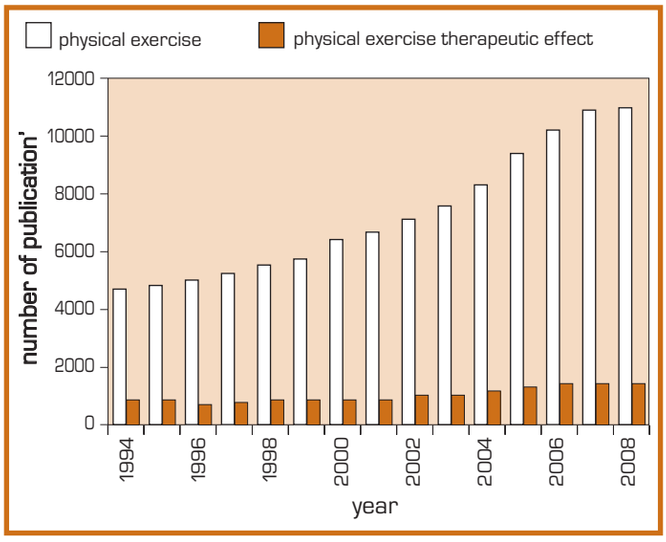

Figure 1: *Evolution of the number of publications referenced in Pubmed database from 1994 to 2008 using different keys words.*

pharmacological agent; unfortunately, we have to recognize that it is not yet the case.

In general terms, pharmacology has to study the molecular, biochemical, and physiological effects of drugs on cellular systems and their mechanisms of action. The broad area covered may be conveniently divided into a number of categories such as pharmacodynamics, toxicology, psychopharmacology, biochemical pharmacology and clinical pharmacology. Applied to physical exercise, many of these aspects have not been systematically considered or they have only recently been taken into account.

In industrialized societies, a sedentary lifestyle is a major risk factor for cardiovascular diseases, including atherosclerosis, heart failure, hypertension and stroke, and because of this, a new trend is developing, namely giving greater importance to physical exercise in the promotion of health care (4). Booth developed an interesting thesis in order to wage war against physical inactivity. Modern humans have inherited a genome initially appropriate for a physically active lifestyle necessary for hunter-gatherer societies; now they have to have a physically inactive lifestyle. Thus our current genome is maladapted, resulting in abnormal gene expression, which in turn frequently manifests itself as clinically overt disease (5).

For these reasons, we can hope that the pharmacology of physical exercise will be specifically studied so that it will become a real therapeutic agent (6).

PHYSICAL EXERCISE AS A THERAPEUTIC AGENT IN REHABILITATION

We could think that Physical and Rehabilitation Medicine is exemplary because it is the daily use of physical activity as a therapeutic agent, but in current practice it is not yet the case; the prescription of physical activity has not yet been perfectly defined.

Of course, the lack of knowledge of the mechanisms involved in the action of physical exercise may explain this paradox; nevertheless a supplementary difficulty is that it is necessary to teach the patient to do different kinds of exercise. This raises questions concerning learning, considered as a rehabilitation strategy.

With regard to learning, we can say that it involves two different and complementary aspects included in the concept of plasticity (7). One part deals with brain systems that mediate the practice of a motor skill and the other concerns brain activity associated with motor skill acquisition during teaching. Brain systems organise a motor skill and induce an action able to modify the environment. Simultaneously, the environmental modification so induced constitutes stimuli that are able to adapt, that is to say able to format the activity of a brain system in a way that corresponds exactly to the desired action.

In the learning process, during a rehabilitation session, the caregiver and the patient appear as two characters playing two different roles. The patient commonly has to learn by practice and/or by instruction how to do or how to perform a task, using implicit or explicit learning procedures. The caregiver is the teacher who knows and understands the principles of teaching and learning. Schematically he/she uses instructions that could be summarized as: “Do it like as”, “Do it like I do it”, and “Do it in a way that feels right for you”. Perhaps it could possible to simply say “Watch as I do it” because a study recently demonstrated that observing others’ actions can facilitate basic aspects of motor performance, such as force production, even if the subjects are not required to immediately reproduce the observed actions, and if they are not aware that observation can constitute the basis for the procedure (8).

Furthermore, these instructions suppose that there are standards. Some of them are defined as evidence based principles of medicine, established in experimental conditions. Possibly they may not be appropriate to the patient’s way of functioning because, for example, functioning and physiological values are not correlated (9, 10).

Rehabilitation is “the use of all means aimed at reducing the impact of disabling and handicapping conditions and at enabling people with disabilities to achieve optimal integration” (WHO definition). Strictly taking into account this definition, the caregiver and the patient may not perceive the problem in the same way and the caregiver has to remember that “the overall aim of rehabilitation is to enable people with disabilities to lead the life that they would wish” (11). The patient or his/her family has to accept the limits of such a choice, and all of them together have to adapt their proposals to changes in the life project.

Finally, physical exercise could induce some deleterious effects illustrated by specific learned disuses. One example is neurological dystonia, in which sustained muscle contractions induced by intensive training cause twisting and repetitive movements and abnormal postures; another one is tendonitis.

CONCLUSIONS

From many points of view it is necessary to promote regular physical activity in order to promote health and well being. Furthermore, without doubt, physical exercise constitutes a real therapeutic agent, notably in Physical and Rehabilitation Medicine. However, this speciality has to develop a research plan to understand better the "pharmacology" of this agent and better define the instructions for use by the patients.

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