

Introduction

The interest of diabetologists and diabetic patients in physical exercise as a potential remedy for the correction of disturbances in carbohydrate metabolism dates back to the time when diabetes was first recognized as a disease entity (1). Even the dichotomy of the clinical effects of exercise (i.e., its benefit in milder cases and its potentially detrimental consequences in severe cases of diabetes) already was known 200 yr ago (2). The systematic use of physical exercise as a therapeutic measure in the context of a structured treatment and teaching program for (what we call today) non-insulin-dependent (type II) diabetes, which included glucosuria self-monitoring and flexible nutrition (according to the actual degree of metabolic control and carbohydrate tolerance), was propagated with admirable clarity by Bouchardat in the middle of the last century (3). Physical exercise and training had become one of the three symbolic therapeutic horses in the Troica formation of the Joslin medal, and they have invariably been discussed extensively in the therapy sections of all textbooks on clinical diabetology. Why then did a rather large group of clinical diabetologists, epidemiologists, physiologists, biochemists, and exercise physiologists feel it appropriate to meet for a symposium on diabetes and exercise in May 1990, already the fourth time in 15 yr? (After Santa Ynez Valley, CA, 1978; Olympia, Greece, 1980; and Burlington, VT, 1983.)

As the organizers of the *Diabetes & Exercise '90* symposium, we hope that this issue of *Diabetes Care*, kindly sponsored by an educational grant from Bayer AG, Lever Kusen, Germany, will lead to the answers with good reason. Since the last meeting of the group in Vermont in 1983, a somewhat controversial, rather sobering National Institutes of Health

(NIH) consensus statement that downplayed the potential role of exercise in the treatment of type II diabetes mellitus (4) has appeared and, on the other hand, an overwhelming increase in the interest of diabetic patients in sports and physical activity has become apparent (e.g., by the drastic increase in the number of publications directed to sports activities in the journals edited for diabetic patients all over the world). Furthermore, important new insights into the molecular biology and physiology of glucose transport in resting and contracting muscle have been derived from the identification of glucose transporters and the regulatory mechanisms governing their activities. Pushed by the legitimated desire of diabetic patients to participate in various physical activities, sports, and games, diabetologists have focused on the evaluation of the metabolic and hormonal consequences of short- and long-term exercise and training in diabetic individuals, the identification of particular risks of exercise in these patients, and the measures and precautions to prevent them. With this issue, we have tried to draw attention to some selective developments in the field of diabetes and exercise, as they relate to the earlier accounts (5–7) of this truly interdisciplinary field.

Much of the momentum motivating clinical diabetologists to reinvestigate a number of aspects of acute exercise in insulin-dependent (type I) diabetes has been prompted by the activities following the 1988 founding of the International Diabetic Athletes Association (IDAA) in Arizona. In this issue of *Diabetes Care*, P. Harper and U. Thurm have described the objectives and actions of this self-help group organization that has, by now, rapidly and most successfully branched out all over the world. This development underscores the enormous interest of diabetic patients in

sports and athleticism and, at the same time, the apparent lack of physicians who are adequately qualified to counsel and advise diabetic athletes. The diabetic individuals who formed IDAA have built up an enormous body of experience and expertise concerning all aspects of diabetes, physical exercise, and athleticism in order to make it available to fellow patients for counseling and support. IDAA has become a model of a successful self-help group that can provide substantially more expertise for a particular subgroup of diabetic patients than the medical profession on the whole is able to offer. Members of the IDAA have become promoters of intensified insulin therapy, including systematic blood glucose monitoring and self-adaptation of insulin therapy combined with a very flexible (liberalized) life-style and diet, a new form of therapy that, at least in the United States, is still viewed with critical skepticism by many physicians. Among diabetologists and expert diabetic patients, it has become evident that physical exercise cannot and should not be used for the sole purpose of improving otherwise unsatisfactory glycemic control in type I diabetes. On the other hand, all efforts should be taken to advise and support those type I diabetes patients who are motivated to exercise to do so under optimal conditions for performance and enjoyment and with minimal risk of causing acute complications. Counseling and advice for diabetic athletes need to be based on adequate clinical research. This issue contains some examples of such studies, some initiated from questions asked by patients and others based on particular experiences of both diabetologists and/or expert diabetic patients.

Quite different is the situation with regard to the effects of exercise and physical training in type II diabetes. Based on animal experimentation and evidence from some smaller studies in humans with type II diabetes and glucose intolerance/insulin resistance, most experts have always viewed physical ex-

exercise as a potentially important therapeutic measure in type II diabetes (8,9), despite the somewhat contrary consensus statement of the NIH (4). However, many questions remain unanswered, even after the presentation of the most voluminous positive experience with exercise training in type II diabetic patients by S. Schneider, as included in this issue. Thus, if there is a positive effect of exercise training on glucose tolerance, how long does it persist after the last bout of exercise? What amount of exercise training is necessary (intensity, duration per week) to exert such a positive effect? Who are the patients most likely to benefit from such an effort? Is the quite negative outlook of Skarfors et al. (10) that only a minority of type II diabetes patients are eligible for a training program and that of those who are eligible only a small fraction can be successfully kept within a training program for more than 1 yr generally applicable? Or do we have to follow Eriksson and Lindgärde's (11) opinion that only those type II diabetes patients below 55 yr of age should be considered for exercise therapy? This would mean that the vast majority of patients with type II diabetes should not be eligible for systematic attempts to improve metabolism through increasing physical activity. This may be one of the clinically relevant questions for which a clear-cut answer based on unequivocal prospective control studies may never become available. If so, the therapeutic intervention may have to be negotiated with the patient on the basis of soft evidence rather than prescribed based on hard end-point-related data.

There is some growing indirect evidence in favor of exercise programs in type II diabetes that may become a strong argument during a doctor-patient negotiation. Over and above the evidence suggesting a potential role of physical activity in the prevention of atherosclerosis, as reviewed in this issue (by Ruderman), there is the important issue of whether it is also effective in prevent-

ing type II diabetes to occur in individuals who are at (genetic) risk for this disorder, as reviewed in this issue by H. King and N. B. Ruderman. Since then, three important publications have appeared that highlight the efficacy of physical training in preventing the manifestation of type II diabetes (11-13). Based on this evidence, it becomes more and more likely that exercise training can play a major role in the primary and secondary prevention/therapies of type II diabetes in younger age-groups, a conclusion that would be compatible with a considerable body of evidence regarding the pathophysiology of insulin resistance/glucose intolerance/type II diabetes and the so-called metabolic syndrome "diabesity" (14,15) and the likelihood of a primary therapeutic benefit by an increase in the body's insulin sensitivity through regular exercise.

Expert diabetologists, in cooperation with exercise physiologists, sports educators, and patient self-help groups, are now being asked to confirm this suggestive evidence and to implement it on an individual/cohort basis. Thus, a future symposium of diabetes and exercise may well bring professionals together with expert diabetic patients to exchange data and experience in order to formulate recommendations and advice concerning diabetes and exercise, and the role of exercise/training in the treatment and prevention of type II diabetes, with more precision than this may be possible today.

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