Physical Activity and Diabetes Complications in Patients With Type 1 Diabetes

The Finnish Diabetic Nephropathy (FinnDiane) Study

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Physical activity exerts numerous beneficial health effects, and the evidence favoring a physically active lifestyle in the treatment of chronic diseases is substantial (1). For patients with diabetes, physical activity is considered important (2). In theory, regular physical activity may prevent diabetes complications through beneficial effects on glycemic control, insulin sensitivity, blood pressure, lipid profile, and endothelial function. However, physical activity could also cause adverse effects or patients may not be able to exercise due to complications. Little, however, is known about the relationship between physical activity and diabetes complications (3). Therefore, we investigated the associations between physical activity and microvascular and macrovascular diabetic complications in a large cohort of patients with type 1 diabetes from the Finnish Diabetic Nephropathy (FinnDiane) Study.

RESEARCH DESIGN AND METHODS — The FinnDiane Study and the assessment of self-reported leisure-time physical activity (LTPA) by a questionnaire have previously been described (4). This is a cross-sectional analysis of 1,945 patients with data on LTPA. Renal status was based on at least three urine collections. Renal function was evaluated by the Cockcroft-Gault formula (5) for estimated creatinine clearance. Data on retinopathy and cardiovascular disease (CVD) were obtained from medical records. Differences between groups were evaluated with the Kruskal-Wallis test for total LTPA; otherwise, the χ^2 test was used.

RESULTS — Mean ± SD age was 38.5 ± 12.3 years (range 10.2–81.8), duration of diabetes 23.4 ± 12.8 years (0.3–61.3), BMI 25.1 ± 3.5 kg/m^2, A1C 8.3 ± 1.4%, and LTPA 19.7 (10.1–35.5) MET h/week; 48.2% of patients were men. Total LTPA was not associated with sex, age, or with duration of diabetes.

Table 1 shows total LTPA, components of LTPA, and previous LTPA habits according to various degrees of diabetes complications. Physical inactivity, as well as low-frequency and low-intensity LTPA, were more common in patients with diabetic nephropathy and proliferative retinopathy than in those without these complications. Patients with microalbuminuria more frequently reported low-intensity LTPA than those with normal urinary albumin excretion rate (P = 0.047 adjusted for age and sex). Impaired renal function and CVD were also associated with low-intensity LTPA.

We further performed multiple logistic regression models controlling for duration of diabetes, sex, and BMI. Low-frequency LTPA (<1 session/week) (odds ratio 1.90 [95% CI 1.39–2.60]) and low-intensity LTPA (2.31 [1.72–3.10]) were independently associated with diabetic nephropathy, while log-transformed total LTPA was not (0.88 [0.76–1.02]). Low-intensity LTPA, but not total LTPA or low-frequency LTPA, was independently associated with proliferative retinopathy (1.49 [1.15–1.93]) and CVD (2.58 [1.79–3.74]). Additionally controlling for proliferative retinopathy and CVD, low-intensity (1.90 [1.36–2.66]) and low-frequency (1.93 [1.35–2.76]) LTPA were still associated with nephropathy.

CONCLUSIONS — Patients with diabetic micro- and macrovascular complications reported different patterns of LTPA compared with patients without complications. The most prominent difference was the intensity of LTPA, since low intensity was clearly associated with impaired renal function and increasing degree of proteinuria, retinopathy, and CVD.

Diabetes complications may limit the patient's ability to exercise by several mechanisms. Patients with proliferative retinopathy are recommended to avoid strenuous activities and Valsalva-like maneuvers because of risk of vitreous hemorrhage (2). CVD is an evident limitation because of possible exercise-induced myocardial ischemia, systolic or diastolic cardiac dysfunction, or ischemia in the lower limbs. Diabetic nephropathy is strongly associated with CVD (6); however, our data support that CVD is not the

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Abbreviations: CVD, cardiovascular disease; FinnDiane, Finnish Diabetic Nephropathy; LTPA, leisure-time physical activity.

Table 1—*Physical activity (current and past) in relation to various degrees of diabetes complications*

	n	Total LTPA (MET h/week)	Sedentary	<1 session/week	Low intensity	Duration <2 h/week	<1 session/week in adolescence	Competitive sports	Decreased last 10 years
Normal UAER	1,108	20.3 (10.5–35.0)	23.0	20.6	21.4	22.8	23.3	28.6	48.9
Microalbuminuria	223	19.9 (9.4–39.7)	27.4	22.0	30.5*	25.5	22.2	29.1	50.0
Macroalbuminuria	187	18.0 (7.9–31.7)	32.1*	30.6*	43.7*	28.8	16.8	33.0	60.4*
Dialysis	21	14.5 (2.6–44.3)	38.9	47.6*	61.9*	37.5	25.0	9.5	66.7
Renal transplantation (S-Cr >150 μmol/l)	17	8.3 (1.4–24.7)*	50.0*	37.5	64.7*	40.0	25.0	23.5	70.6
Renal transplantation (S-Cr <150 μmol/l)	43	22.3 (14.7–55.5)	18.9	23.8	55.8*	11.1	16.3	32.6	58.1
Renal function									
Normal	1,026	19.3 (10.5–34.3)	23.5	21.5	21.5	23.8	21.4	30.6	50.7
Mildly impaired	521	18.9 (9.7–36.4)	25.5	21.0	29.5†	23.5	24.5	23.8†	49.1
Impaired	140	23.8 (9.5–35.1)	25.9	22.6	45.7†	21.6	20.1	32.1	50.0
Severely impaired	37	18.3 (6.3–37.3)	30.3	43.2†	56.8†	28.1	8.3	24.3	81.1†
Retinopathy									
No	880	19.7 (11.0–35.6)	21.7	19.2	18.6	22.6	22.5	31.2	48.3
Background	399	18.9 (9.5–34.3)	25.7	26.4‡	26.5‡	23.9	19.7	28.9	55.4‡
Proliferative	601	19.8 (8.5–35.6)	27.9‡	25.1‡	39.3‡	23.8	21.8	27.8	53.3
CVD									
No	1,769	19.7 (10.2–35.5)	24.0	22.2	24.1	23.4	22.2	29.3	50.1
Yes	158	18.0 (7.7–36.4)	28.6	23.6	56.4‡	25.0	17.4	31.2	65.6‡
Diabetic nephropathy									
Without CVD	192	19.5 (7.5–33.0)	32.3	31.1	40.5*	29.1	18.4	30.4	58.5
With CVD	74	17.5 (7.7–39.3)	27.6	30.1	68.1*§	19.2	15.3	31.5	67.1

Data are medians (interquartile range) or percentages. Sedentary: total LTPA <10 MET h/week. Low-intensity LTPA: very light to light activities, grade 0–1 out of an intensity scale of 0–4. Micro- and macroalbuminuria: urinary albumin excretion rate (UAER) 30–299 and ≥300 mg/24 h (24-h collections) or 20–199 and ≥200 μg/min (overnight collections), respectively, in at least two of three consecutive urine collections. Normal renal function: Cockcroft-Gault–estimated creatinine clearance ≥90 ml/min per 1.73 m^2; mildly impaired, 60–89 ml/min per 1.73 m^2; impaired, 30–59 ml/min per 1.73 m^2; and severely impaired, <30 ml/min per 1.73 m^2. Cardiovascular disease: symptomatic coronary heart disease, myocardial infarction, coronary artery procedure (bypass surgery or angioplasty), stroke, limb amputation, or peripheral artery procedure. Diabetic nephropathy: macroalbuminuria, dialysis, or renal transplantation. *$P < 0.05$ vs. normal urinary albumin excretion rate. †$P < 0.05$ vs. normal renal function. ‡$P < 0.01$ vs. none. §$P < 0.01$ vs. without CVD. S-Cr, serum creatinine.

sole driving force behind reduced LTPA in patients with nephropathy. A decline in renal function, especially when due to diabetic nephropathy (7), is associated with reduced blood hemoglobin concentration as a result of impaired erythropoietin production, which may impair oxygen delivery during exercise. Autonomic neuropathy may cause inadequate responses in heart rate and blood pressure during exercise (8). Peripheral neuropathy and foot ulcers may impair walking and running ability. Diabetes complications, as well as diabetes itself, are further associated with endothelial dysfunction (9,10), which may impair vasodilatation in exercising skeletal muscle tissue. Finally, diabetes complications are associated with depression (11), which may decrease physical activity.

The observed differences in LTPA between patients with various diabetes complications are probably to a large extent due to the abovementioned exercise-limiting factors. However, the difference in LTPA in patients with microalbuminuria compared with a normal urinary albumin excretion rate is a potentially important finding. Microalbuminuria in type 1 diabetes is unlikely to cause exercise intolerance because patients with microalbuminuria usually have normal kidney function. Therefore, it is possible that low LTPA precedes the development of microalbuminuria.

The study includes a large number of patients, and LTPA was assessed by a questionnaire previously validated in a Finnish cohort (12). Objective measurements of LTPA, however, were not performed, and bias due to self-reported LTPA is possible. A limitation is the cross-sectional study design. A longitudinal study design will be needed to provide evidence for the role of physical activity in the development and progression rate of diabetes complications.

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