Nutrición Hospitalaria

Nutr Hosp. 2014;29(4):922-928
ISSN 0212-1611 • CODEN NUHOEQ
S.V.R. 318

Original / *Deporte y ejercicio*

High prevalence of inactivity among young patients with type 1 diabetes in south Spain

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Abstract

Objectives: **To describe usual physical activity level and analyze its association with metabolic control and presence of microvascular complications in a cohort of patients with type 1 diabetes (DM-1) in south Spain.**

Methods: **Observational, cross-sectional study that included one hundred thirty patients, aged 33.9 ± 11.5 years-old with disease duration of 16.5 ± 9.5 years that consecutively were recruited among patients attending the Endocrinology Service of Puerta del Mar University Hospital (Cádiz, Spain). Usual physical activity level was assessed using the "General Practice Physical Activity Questionnaire" (GPPAQ) together with clinical, anthropometric, metabolic parameters and microvascular complications.**

Results: **DM-1 patients were grouped in four categories of physical activity level: inactive (n = 33; 25.3%), moderately inactive (n = 31; 23.8%), moderately active (n = 26; 20.0%) and active (n = 40; 30.9%). We observed no significant differences in glycated haemoglobin (HbA1c) level between the different physical activity groups analyzed. Patients classified as moderately active and active were more often men, significantly younger and presented lower plasmatic levels of triglycerides than patients classified as inactive or moderately inactive, with no differences in other clinical or anthropometric variables. In addition, active and moderately active patients had a lower prevalence of diabetic retinopathy and microvascular complications in general compared to inactive or moderately inactive patients.**

Conclusions: **Half of patients with type 1 diabetes evaluated were classified as inactive and these patients had a higher prevalence of diabetic retinopathy than active patients. No difference in HbA1c levels was documented among different groups of physical activity.**

(*Nutr Hosp.* 2014;29:922-928)

DOI:10.3305/nh.2014.29.4.7225

Key words: *Type 1 diabetes. Glycated haemoglobin. Metabolic control. Physical activity.*

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Recibido: 16-XII-2013.
Aceptado: 15-I-2014.

ELEVADA PREVALENCIA DE INACTIVIDAD FÍSICA EN PACIENTES JÓVENES CON DIABETES TIPO 1 DEL SUR DE ESPAÑA

Resumen

Objetivos: **Describir el nivel de actividad física habitual y analizar su asociación con el control metabólico y la presencia de complicaciones microvasculares en una cohorte de pacientes con diabetes tipo 1 (DM-1) del sur de España.**

Métodos: **Estudio transversal observacional que incluyó ciento treinta pacientes de 33,9 ± 11,5 años de edad y una duración de la enfermedad de 16,5 ± 9,5 años que fueron reclutados consecutivamente en el Servicio de Endocrinología del Hospital Universitario Puerta del Mar (Cádiz, España). El nivel de actividad física habitual fue evaluado utilizando el "General Practice Physical Activity Questionnaire" (GPPAQ) conjuntamente con diversos parámetros clínicos, antropométricos, metabólicos y de complicaciones microvasculares.**

Resultados: **Los pacientes con DM-1 fueron agrupados en cuatro categorías de nivel de actividad física: inactivo (n = 33; 25,3%), moderadamente inactivo (n = 31; 23,8%), moderadamente activo (n = 26; 20,0%) y activo (n = 40; 30,9%). No observamos diferencias significativas en el nivel de hemoglobina glucosilada (HbA1c) entre los diferentes grupos de actividad física analizados. Los pacientes clasificados como moderadamente activos y activos fueron con mayor probabilidad hombres, más jóvenes y con menores niveles plasmáticos de triglicéridos que los pacientes clasificados como inactivos o moderadamente inactivos, sin encontrarse diferencias en otras variables clínicas o antropométricas. Adicionalmente, los pacientes activos y moderadamente activos tenían una menor prevalencia de retinopatía diabética y de complicaciones microvasculares en general comparados con los pacientes inactivos o moderadamente inactivos.**

Conclusiones: **La mitad de los pacientes con DM-1 evaluados fueron clasificados como inactivos y estos pacientes tenían mayor prevalencia de retinopatía diabética que los pacientes activos. No fueron documentadas diferencias en los niveles de HbA1c entre los diferentes grupos de actividad física.**

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Palabras clave: *Diabetes tipo 1. Hemoglobina glucosilada. Control metabólico. Actividad física.*

Abbreviations

DM-1: Type 1 diabetes.
HbA1c: Glycated Haemoglobin.
LDLc: LDL cholesterol.
HDLc: HDL cholesterol.
BMI : Body Mass Index.
GPPAQ: General Practice Physical Activity Questionnaire.
SD: Standard deviation.
Kg: Kilograms.

Introduction

Type 1 diabetes mellitus (DM-1) is a chronic disease characterized by the development of sustained hyperglycaemia due to an absolute or almost absolute deficiency of insulin, mediated by autoimmune destruction of pancreatic beta cells. Although it can occur at any age, it primarily affects children and young people, with an estimated prevalence in Spain of 0.2-0.3%, representing between 10 and 15% of all people with diabetes[1]. Glycated haemoglobin (HbA1c) has been shown to be a good indicator of metabolic control, being recommended that patients with DM-1 obtain HbA1c levels below 7% because its demonstrated that intensive therapy –in order to achieve mean HbA1c levels below 7%– reduces the risk of chronic complications (ocular, kidney and cardiovascular complications) in patients with DM-1[2-3].

The practice of regular physical activity and the adherence to a balanced diet are cornerstones in the treatment of diabetes mellitus[4-7]. In this sense, in a meta-analysis of 24 intervention trials that included 1435 patients with DM-1, physical exercise was associated with an improvement in HbA1c of 0.33%[5], while other investigations have documented that sedentary habits, like watching television, are associated with an increase in HbA1c levels in type 1 diabetic patients[8-9]. Although some studies suggest a favourable effect of physical activity on the development or progression of chronic complications in patients with DM-1[10-12], there is insufficient information to confirm this statement.

Due to the beneficial effects of physical activity on diabetes mellitus, the American Diabetes Association (ADA) recommend that people with diabetes should be advised to perform at least 150 min/week of moderate-intensity aerobic physical activity (50-70% of maximum heart rate)[7]. However, there is only little research that investigates the level of physical activity performed by Spanish patients with DM-1[6,13], and its association with the degree of metabolic control and presence of microvascular complications (ocular or renal).

Research design and methods

We designed an observational, cross-sectional study to describe the level of regular physical activity and analyze its association with metabolic control and presence of microvascular complications in a cohort of patients with DM-1 in the south of Spain. One hundred thirty patients (63 males and 67 females), aged 33.9 ± 11.5 years-old with disease duration of 16.5 ± 9.5 years were consecutively recruited among the patients attending the Endocrinology Service of Puerta del Mar University Hospital (Cádiz, Spain). The inclusion criteria were: age from 18 to 60 years-old, diagnostic criteria of DM-1 according to the ADA[7], duration of diabetes longer than 12 months and absence of pregnancy. The study protocol was approved by the local ethical committee of the participating center, and the study was carried out according to the Declaration of Helsinki. Written informed consent was obtained from each patient.

Age, sex, level of education, smoking habit, duration of diabetes, insulin dose, number of hypoglycemic episodes in the last month (defined as blood glucose lower than 50 mg/dl), hypertension and presence of metabolic complications were preliminary recorded by analyzing the medical records of all patients. The day of the interview weight, height, BMI and waist circumference were measured. Hypertension was defined as the determination of level of systolic blood pressure above 130 mmHg and/or diastolic blood pressure level above 80 mmHg and/or taking antihypertensive therapy.Then a blood sample for the determination of glucose, glycated haemoglobin (HbA1c), lipid profile (total cholesterol, LDL cholesterol, HDL cholesterol and triglycerides) urea and creatinine, and urine for determination of urinary albumin and creatinine (normal values were considered those lower than 30 mcg/mg of creatinine) were obtained. Renal failure was established by creatinine levels higher than 1.2 mg/dl. Finally, presence of diabetic retinopathy was assessed by fundus study with non-mydriatic fundus camera, being interpreted all the results by the same ophthalmologist.

All selected patients were interviewed using the General Practice Physical Activity Questionnaire (GPPAQ) (table I). This questionnaire was developed in 2004 by the Department of Public Health and Primary Care of the British National Health Service (NHS)[14], based on the short physical activity questionnaire validated and used by the European Prospective Investigation into Cancer and Nutrition in Norfolk (EPIC-Norfolk Prospective The Population Study)[15].

The GPPAQ was initially designed for use in primary care doctor's office and to assess usual physical activity performed the previous week and its results provided an index of physical activity (Physical Activity Index-PAI-) with four levels: a) Inactive: Sedentary job and no physical exercise or cycling; b) Moderately inactive: Sedentary job and some but < 1 hour physical exercise and/or cycling per week OR Standing job and no physical exercise or cycling; c) Moderately active: Sedentary job and 1-2.9 hours physical exercise and/or cycling per week OR Standing

Table I
General Practice Physical Activity Questionnaire(GPPAQ)

Please tell us the type and amount of physical activity involved in your work:

		Mark only 1 box
a	I am not in employment (e.g. retired, retired for health reasons, unemployed, full-time carer etc.)	
b	I spend most of my time at work sitting (such as in an office)	
c	I spend most of my time at work standing or walking. However, my work does not require much intense physical effort (e.g. shop assistant, hairdresser, security guard, childminder, etc.)	
d	My work involves definite physical effort including handling of heavy objects and use of tools (e.g. plumber, electrician, carpenter, cleaner, hospital nurse, gardener, postal delivery workers etc.)	
e	My work involves vigorous physical activity including handling of very heavy objects (e.g. scaffolder, construction worker, refuse collector, etc.)	

During the last week, how many hours did you spend on each of the following activities? Please answer whether you are in employment or not:

		None	*Some but less than 1 hour*	*1 hour but less than 3 hour*	*3 hours or more*
a	Physical exercise such as swimming, jogging, aerobics, football, tennis, gym workout, etc.				
b	Cycling (including cycling to work) and during leisure time.				
c	Walking (including walking to work), shopping, etc.				
d	Housework or childcare.				
e	Gardening or DIY.				

How would you describe your usual walking pace?

Slow pace (i.e. less than 3 mph)		Steady average pace	
Brisk pace		Fast pace (i.e. over 4 mph)	

job and some but < 1 hour physical exercise and/or cycling per week OR Physical job and no physical exercise or cycling and d) Active: Sedentary job and ≥3 hours physical exercise and/or cycling per week OR Standing job and 1-2.9 hours physical exercise and/or cycling per week OR Physical job and some but < 1 hour physical exercise and/or cycling per week OR Heavy manual job. This questionnaire combined physical activity at work with leisure time in a single index. In this regard, numerous studies have shown that this combination is more consistently associated with mortality than the single use of any of its components[16]. The process of completing the questionnaire and obtaining the result is approximately two minutes, so that the doctor can ask queries and record the results of each patient.

Statistical analysis

Data was coded, entered and analyzed using 12.0 SPSS version for Windows. The descriptive analysis of

qualitative variables was performed by calculating frequencies and percentages, and of quantitative variables the mean, standard deviation (SD), median and range were determined. After verification of the normality assumption in the sample by Kolmogorov-Smirnov test, the following tests were performed: to compare quantitative variables between independent groups, Student's t test (two groups) or ANOVA (more than two groups) and to compare qualitative variables between independent groups, chi-square test and, when indicated, Fisher's exact test. All significant values refer to 2-tailed test, considering the association to be statistically significant if $p < 0.05$.

Results

We studied 130 patients with DM-1 who met the inclusion criteria for participation in this study. Table II shows how this is a young population (33.9 ± 11.5 years average age) with an important mean duration of diabetes (16.5 ± 9.5 years) and a mean BMI within the normal weight (24.7 ± 3.3 kg/m^2). All patients had intensive insulin therapy indication, with average requirements of 0.74 ± 0.28 IU insulin/kg body weight/day. The mean level of HbA1c was 7.8 ± 1.1%, very similar to the average level of the previous quarter (7.6 ± 1.1%; p>0.05) and only 30% of patients had an HbA1c level ≤ 7%.

All patients properly completed the General Practice Physical Activity Questionnaire (GPPAQ) referenced to the previous week, being observed that 25.3% of the study population belonged to the "inactive" category, although this data could reach 50% of patients if we consider together patients in the "inactive" and "moderately inactive" group. In contrast, 20.0% of patients were classified as moderately active and 30.9% as active (fig. 1).

Patients classified as moderately active and active were more often men and significantly younger than patients classified as inactive or moderately inactive, with no differences in other clinical or anthropometric variables analyzed. In addition, active and moderately active patients had a lower prevalence of diabetic retinopathy and microvascular complications in general compared to inactive or moderately inactive patients (table III).

Finally, there were not significant differences in HbA1c levels between GPPAQ groups (7.6 ± 1.0% versus 8.0 ± 1.1% *versus* 7.9 ± 1.1% *versus* 7.7 ± 1.2% in inactive, moderately inactive, moderately active or active patients, respectively; p:0.487) nor in the

Table II
Characteristics of patients participating in the study (n = 130)

	Results
Clinical Characteristics	
Mean Age (years)	33.9 ± 11.5
Male (%)	63 (48.5%)
University studies (%)	39 (30.0%)
Mean diabetes evolution (years)	16.5 ± 9.5
Insulin doses (UI/kg/day)	0.74 ± 0.28
Hypoglycaemia in the previous month (number)	7.4 ± 5.8
Physical examination	
Weight (kg)	69.7 ± 12.9
BMI (kg/m^2)	24.7 ± 3.3
Waist Circunference (cm)	84.3 ± 11.4
Comorbidities and Chronic complications	
Smoking habit (%)	29 (22.3%)
Hypertension (%)	18 (13.8%)
Diabetic Retinopathy (%)	74 (56.9%)
Diabetic Nephropathy (%)	
No nephropathy	110 (85.9%)
Albuminuria	14 (10.9%)
Renal Failure	4 (3.2%)

Results are expressed as mean ± standard deviation;
BMI: Body Mass Index; Kg: Kilograms.

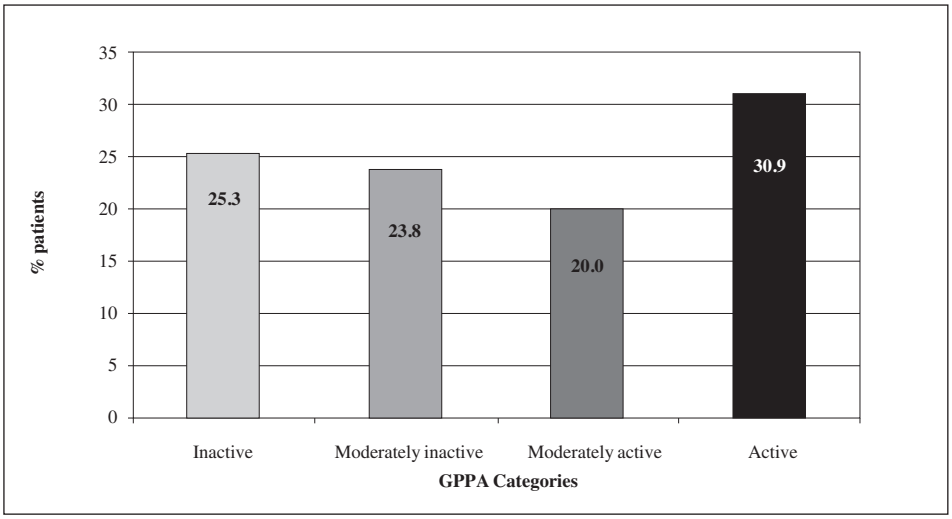

Fig. 1.—GPPAQ Categories in studied patients.

Table III
Clinical variables in different subgroups of physical activity levels

GPPAQ Categories	*Inactive (n = 33)*	*Moderately inactive (n = 31)*	*Moderately active (n = 26)*	*Active (n = 40)*	*p*
Mean age (years)	37.2 ± 11.0	35.4 ± 11.8	30.2 ± 11.7	31.5 ± 11.6	**0.046**[1]
Male (%)	16 (42.1%)	8 (25.0%)	15 (57.7%)	25 (62.5%)	**0.010**[1]
Universitary studies (%)	4 (11.1%)	3 (9.4%)	3 (11.5%)	3 (2.3%)	0.986
Diabetes evolution (years)	16.8 ± 8.6	18.1 ± 9.0	13.7 ± 9.9	16.4 ± 10.0	0.357
Weight (kg)	71.0 ± 12.9	66.3 ± 12.7	67.5 ± 10.7	72.1 ± 13.7	0.188
BMI (kg/m^2)	25.7 ± 3.2	24.5 ± 3.5	23.3 ± 3.0	24.9 ± 3.5	0.056
Waist Circunference (cm)	87.5 ± 12.2	82.1 ± 10.4	80.8 ± 10.0	84.6 ± 12.2	0.134
Insulin (UI/kg/day)	57.9 ± 24.2	50.5 ± 20.1	51.3 ± 24.6	49.6 ± 21.4	0.406
Hypoglycemia last month (n)	7.0 ± 5.1	7.0 ± 4.5	8.0 ± 6.1	7.5 ± 7.2	0.875
Smoking habit (%)	7 (20.6%)	8 (25.0%)	9 (34.5%)	5 (12.5%)	0.193
Hypertension (%)	4 (11.1%)	5 (15.6%)	2 (7.7%)	7 (17.5%)	0.683
Diabetic Retinopathy (%)	21 (61.8%)	23 (71.8%)	9 (34.5%)	21 (52.5%)	**0.033**[1]
Diabetic Nephropathy (%)					
No nephropathy	26 (78.8%)	25 (80.6%)	23 (17.7%)	36 (90%)	
Albuminuria	6 (18.2%)	5 (16.1%)	1 (3.3%)	2 (10.0%)	
Renal failure	1 (3.0%)	1 (3.3%)	2 (7.7%)	0 (0.0%)	
Microvascular complications (%)	22 (64.7%)	23 (71.8%)	9 (34.5%)	21 (52.5%)	**0.011**[1]

Results are expressed as mean ± standard deviation; BMI: Body Mass Index; Kg: Kilograms
[1]$p < 0.05$ compared between moderately active or active patients and others two groups of inactive patients.

percentage of patients with HbA1c ≤ 7% (38.2% *versus* 21.8% *versus* 23.1% *versus* 32.5% in inactive, moderately inactive, moderately active or active patients, respectively; p:0.652). However, active patients had lower levels of plasma triglycerides compared to other patients groups (103.2 ± 52.2 *versus* 88.0 ± 62.0 *versus* 92.2 ± 56.9 *versus* 63.4 ± 20.6 mg/dl in inactive, moderately inactive, moderately active or active patients, respectively; p: 0.007). Women also had lower plasma triglycerides levels than men (70.7 ± 30.0 versus 97.8 ± 64.0; $p < 0.001$) with no different between sex in the rest of variables analyzed. No significant differences were observed in the other analytical variables analyzed between physical activity groups (table IV).

Discussion

Regular physical activity is associated with a significant health benefit in general population[17-19], so the U.S. Department of Health and Human Services recommends adults over 18 years to take at least 150 minutes of moderate aerobic intensity or 75 minutes of vigorous intensity exercise per week, or an equivalent combination of both[20]. Similarly, the ADA[7] recommends people with diabetes to perform at least 150 minutes of moderate-intensity aerobic exercise (50-70% of maximum heart rate) a week. This recommendation is because (in addition to the health benefits in general) in patients with DM-1 physical activity practice is associated with metabolic control improvement[5,21], better levels of major cardiovascular risk factors[22-27], sense of well being improvement[21] and with lower incidence of cardiovascular disease and mortality[28].

While there is sufficient evidence to recommend the incorporation of physical activity to the treatment of type 1 diabetic patients, the type is still not clear, duration and intensity should be recommended individually to each patient. However, it is also documented in children, adolescents and young adults that sedentary

Table IV
Analytical variables in different subgroups of physical activity levels

GPPAQ Categories	*Inactive (n = 33)*	*Moderately inactive (n = 31)*	*Moderately active (n = 26)*	*Active (n = 40)*	*p*
Glucose	149.5 ± 57.4	157.8 ± 56.4	176.9 ± 95.7	150.4 ± 70.2	0.516
HbA1c	7.6 ± 1.0	8.0 ± 1.1	7.9 ± 1.1	7.7 ± 1.2	0.487
Total cholesterol	190.0 ± 37.8	189.1 ± 22.5	195.4 ± 32.1	175.9 ± 30.0	0.085
LDL cholesterol	116.9 ± 32.1	112.4 ± 23.2	121.2 ± 25.6	107.1 ± 26.4	0.270
HDL cholesterol	53.4 ± 13.4	57.8 ± 14.3	59.9 ± 15.3	55.4 ± 12.1	0.368
Triglycerides	103.2 ± 52.2	88.0 ± 62.0	92.2 ± 56.9	63.4 ± 20.6	**0.007**[1]

Results are expressed as mean ± standard deviation.
[1]$p < 0.05$ compared between active and others three groups of patients.

behaviour (such as using the computer or watching TV) is associated with poorer metabolic control, expressed in higher levels of HbA1c[8-9].

In our study we found no differences in HbA1c levels between groups of physical activity categories obtained by GPPAQ, similar to the results reported by other observational studies[29-30]. In this sense, a study published in 2011 that assessed sedentary behaviour habits, self-reported physical activity and socioeconomic status in 296 children, adolescents and young adults with DM-1, found no association between physical activity and HbA1c levels[29]. Similarly, a recent study published in 2012 that assessed physical activity, maximal oxygen consumption and body composition in 75 adults with DM-1 and 75 controls without diabetes, found that physical activity was not associated with HbA1c between adults with DM-1[30]. In contrast, in the FinnDiane Study[26] the authors reported that the practice of self-reported physical activity in leisure time was associated with improved glycemic control (in HbA1c levels) in women but not in men. Similarly, in a large observational study that analyzed the impact of the frequency of regular physical activity (AFR) in self-reported cardiovascular risk factors in 23.251 patients with DM-1 from 209 centers in Germany and Austria, reported than HbA1c levels were lower in patients with a higher frequency of AFR[27].

The results of our study also suggest that physical activity may reduce cardiovascular risk in the study population because of its positive impact on the lipid profile. In this way, patients classified as moderately active or active had lower levels of total cholesterol, LDLc and triglycerides and higher HDLc levels than patients classified as inactive or moderately inactive, reaching statistical significance in the lower level of triglycerides in active patients compared to other groups, following the results reported by several studies[26-28]. Thus, Herbst et al communicated that type 1 diabetic patients with more frequency of regular physical activity showed lower levels of total cholesterol, LDLc and triglycerides and higher levels of HDLc[27]. Finally, in our study we found that active and moderately active patients showed a lower prevalence of diabetic retinopathy and microvascular complications (ocular or renal) in general compared to patients in the inactive and moderately inactive group. This is consistent with what is shown in other studies that suggest that physical activity produces a favourable effect on the development and progression of chronic complications in patients with DM-1[10-12].

In conclusion, half of southern spanish patients with DM-1 evaluated in our study were classified as inactive using the General Practice Physical Activity Questionnaire, while only 30% were classified as active. Patients classified as moderately active and active were more often men, significantly younger and presented lower plasmatic triglycerides than patients classified as inactive or moderately inactive. In addition, active and moderately active patients had a lower prevalence of diabetic retinopathy and microvascular complications in general compared to inactive or moderately inactive patients.

Acknowledgements

This study was partially supported by a research grant from the Regional Government of Andalusia (Project 0432-2010).

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