Low physical activity in patients with type 2 diabetes: The role of obesity

C. Fagour\textsuperscript{a,}\textsuperscript{*}, C. Gonzalez\textsuperscript{b}, S. Pezzino\textsuperscript{b}, S. Florenty\textsuperscript{b}, M. Rosette-Narece\textsuperscript{a}, H. Gin\textsuperscript{b}, V. Rigalleau\textsuperscript{b}

\textsuperscript{a} Endocrinologie-diabétologie-nutrition, hôpital Pierre-Zobda-Quitman, CHU de Fort-de-France, 97200 Fort-de-France, Martinique
\textsuperscript{b} Nutrition-diabétologie, hôpital Haut-Lévêque, avenue de Magellan, 33600 Pessac, France

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Abstract

Aims. – Few studies have described ambulatory activity in free-living individuals with type 2 diabetes mellitus (T2DM) using motion sensors, and none included a control group. For this reason, our study compared the physical-activity levels of outpatients with T2DM with subjects without diabetes, and examined the relationship between body mass index (BMI) and physical-activity parameters.

Methods. – Physical-activity levels in 70 outpatients with T2DM and 30 age-, gender- and employment-matched individuals without diabetes were measured using the SenseWear Armband\textsuperscript{TM}, a monitoring device validated against doubly labelled water, to assess total energy expenditure. Patients wore the SenseWear Armband\textsuperscript{TM} on their right arm continuously every day for 1 week.

Results. – Total energy expenditure (<300 kcal/day), number of steps (<1500/day), physical-activity duration (<130 min/day) and active energy expenditure/day (<300 kcal) were all significantly lower (\(P<0.05\)) in patients with T2DM. These measures were inversely correlated with BMI, and remained significant after adjusting for age, gender, employment status and the presence of diabetes.

Conclusion. – Outpatients with T2DM have lower physical-activity levels than their matched controls, a characteristic that is related to their higher BMI.

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Keywords: Physical activity; Type 2 diabetes; Obesity; SenseWear Armband\textsuperscript{TM}

Résumé

Activité physique, et diabète de type 2. Liens avec l’obésité.

Objectifs. – Encourager l’activité physique fait partie des prescriptions de première intention dans la prise en charge des patients atteints de diabète de type 2 (DT2), mais leur niveau spontané d’activité physique n’est pas connu, faute d’étude contrôlée utilisant des mesures objectives. Nous avons comparé le niveau d’activité physique de patients DT2 à celui d’un groupe témoin de sujets non diabétiques, en conditions de vie réelles, et analyisé les relations entre l’indice de masse corporel (IMC) et les paramètres de l’activité physique.

Méthodes. – Nous avons mesuré, en ambulatoire, le niveau d’activité physique de 70 patients atteints de DT2 et de 30 témoins adultes non diabétiques, apparis sur l’âge, le sexe et le statut professionnel, et suivis pour une hypertension artérielle. L’activité physique a été mesurée avec un SenseWear Armband\textsuperscript{TM}, actimètre validé en comparaison à l’eau doublement marquée pour la mesure de la dépense énergétique totale, qui a été porté par tous les sujets durant une semaine, au moins 23 heures par jour.

Résultats. – La dépense énergétique totale (300 kcal/j en moins), le nombre de pas (1500 pas/j en moins), la durée d’activité physique (130 minutes/j en moins), et la dépense énergétique active (300 kcal/j en moins) étaient significativement plus basses chez les patients atteints de DT2, tous \(P<0.05\) que chez les témoins. Les paramètres de l’activité physique étaient en corrélation négative avec l’IMC, et cette relation demeurait significative après ajustement sur l’âge, le sexe, le statut professionnel et la présence d’un diabète.

Conclusions. – Les patients atteints de DT2 ont un niveau d’activité physique réduit par rapport au groupe témoin, en relation avec leur surpoids.

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Mots clés : Activité physique ; Diabète de type 2 ; Obésité ; SenseWear Armband\textsuperscript{TM}

1. Introduction

Despite all the evidence that physical activity is beneficial to health and one of the cornerstones of type 2 diabetes mellitus...
(T2DM) management [1,2], patients with T2DM generally have low physical-activity levels based on recall questionnaires [3], albeit with admitted limitations [4].

Motion sensors, used to monitor body movements, provide another approach to assess physical activity more objectively. These devices basically include simple and inexpensive pedometers (measurement of steps) and technologically more advanced accelerometers (detection of body acceleration) to produce a wealth of information that can be examined to better understand the nature of physical-activity behaviours in people. To date, only a few studies have used accelerometers to assess physical activity in free-living patients with T2DM [5] and none included a control group.

The present study aimed to compare physical-activity levels in 70 T2DM outpatients and 30 subjects without diabetes (control group) using the SenseWear™ Armband Pro3 (SWA), a multisensor body-monitoring device. In addition, patterns of physical activity were correlated with body mass index (BMI), gender, age, employment status and the presence of diabetes.

2. Patients and methods

The study recruited 100 outpatients, who consented to wear the SWA for 1 week, at two French university hospitals in Fort-de-France (n = 22) and Bordeaux (n = 78). Seventy of these outpatients were a consecutive sample of adults with T2DM for at least 3 months and treated by diet, oral medication (n = 63) or basal insulin (n = 7), comprising 36 men and 34 women aged 56 ± 8 years, with HbA1c 7.4 ± 1.3% (57 ± 14 mmol/mol) and BMI 30.2 ± 5.2 kg/m². The 30 controls were adults without diabetes (fasting glycaemia < 7 mmol/L), comprising 15 men and 15 women aged 56 ± 7 years, with fasting glycaemia 5.44 ± 0.6 mmol/L and BMI 27.5 ± 5.3 kg/m², followed-up for arterial hypertension. Their weight, height, fasting glycaemia and HbA1c were measured at the time of inclusion. Hospitalized patients, those who were pregnant or had physical limitations such as diabetic foot ulcer or uncontrolled coronary insufficiency were excluded. Age, gender, employment status (45.7% of workers had diabetes vs 46.7% of controls) and occupational category (15.7% of diabetics had manual occupations vs 23.3% of controls) did not differ significantly between the two groups.

Ambulatory patterns of physical activity were recorded with the same SWA device worn on the right arm continuously every day for 1 week. Participants were asked to take it off no more than 1 h/day for showers or water activities. Subjects were also given no advice on physical activity, but were informed that it was being recorded. Total energy expenditure (TEE), active energy expenditure (AEE), physical-activity duration (PAD) and the number of steps per day were recorded. Physical activity was defined as moderate/vigorous activity [≥ three metabolic equivalents (METs)], where 1 MET is the rate at which an adult burns kilocalories while sitting quietly, or approximately 1 kcal/kg body weight/h. The proportion of patients who walked above 10,000 steps/day as recommended [6] was also analyzed. All participants gave their written informed consent to have their physical activity recorded.

The results are expressed as means ± SD unless otherwise specified. The results are expressed as means ± SD and compared by Chi² and t tests as appropriate.

3. Results

The total “on-body time” for the armband was similar during the 7-day period in the two groups (23.1 ± 1.2 h). As shown in Table 1, the diabetes patients had lower levels of physical activity than the controls. They also had higher BMIs such that 50% were obese (vs 20% of controls; P<0.05). Levels of physical activity did not differ according to diabetes treatment (diet/oral medications/bedtime insulin).

Physical-activity parameters (AEE, PAD and steps/day) were inversely correlated with BMI (r = −0.262, −0.268 and −0.305, respectively; all P<0.01) for the entire study cohort. These relationships remained significant after adjusting for age, gender, presence of diabetes, employment status and occupational category.

4. Discussion

So far, few studies have described ambulatory activity in free-living patients with T2DM. The lack of regular physical activity in most diabetes patients was described by Morrato et al. [3], based on self-reported questionnaires from a nationally representative survey of the US population. Recall questionnaires are adapted to study large populations (n = 23,226 patients with T2DM), but are limited by subjective interpretations, and memory and report variations, such that time spent in vigorous-intensity activities may be overestimated while habitual everyday activities are underestimated [4]. Objective methods are therefore preferable for optimal assessment of physical activity because they are not subject to the many sources of error associated with self-reported measures [4].

Pedometers have gained popularity in research and practice settings to monitor the number of steps taken in free-living situations. Pedometer results correlate strongly with those of

| Table 1 | Type 2 diabetes mellitus (T2DM) patients’ general characteristics and physical-activity data compared with those of the matched controls. |
|-----------------------------------------------|
| T2DM patients (n = 70) | Controls (n = 30) | P value |
|-----------------------------------------------|
| Age (years) | 56 ± 8 | 56 ± 7 | NS |
| Women/men (n/n) | 34/36 | 15/15 | NS |
| Workers (%) | 45.7 | 46.7 | NS |
| Body mass index (kg/m²) | 30.2 ± 5.2 | 27.5 ± 5.3 | 0.019 |
| Total energy expenditure (kcal/day) | 2684 ± 509 | 2997 ± 759 | 0.017 |
| Active energy expenditure (kcal/day) | 694 ± 605 | 1086 ± 652 | 0.005 |
| Physical-activity duration (min/day) | 116 ± 99 | 247 ± 411 | 0.013 |
| Steps/day (n) | 7400 ± 3387 | 8924 ± 3652 | 0.047 |
| Patients taking ≥ 10,000 steps/day (%) | 17.1 | 36.7 | 0.04 |

Data are presented as means ± SD unless otherwise specified.
accelerometers [7], but these data alone cannot assess intensity, frequency or duration of activity. Tudor-Locke et al. [8] used pedometers to determine ambulatory activity in 160 free-living patients with T2DM (age: 52 ± 5 years; BMI: 32.3 ± 5.7 kg/m²). In this more obese group, they found slightly fewer steps per day (6662 ± 3080) in comparison to our present patients. More recently, Crinière et al. [9] reported a mean of 7110 steps/day with pedometers used by 143 T2DM outpatients with a mean age of 60.9 ± 10.5 years. In these studies, as in the present one, patients with T2DM were in the same low-activity category: 5000–7499 steps/day [6]. This is consistent with accelerometer-determined step counts: an average of 6800 steps/day has been reported (range: 4596–9030) in studies of T2DM patients [5,10]. It should be noted, however, that none of these studies was controlled with an age- or gender-matched group without diabetes, as was our present study.

In contrast to other accelerometers, the SWA has been validated against doubly labelled water for the assessment of TEE in outpatients with T2DM [11]. Jansen et al. [12] recently reported SWA-recorded physical-activity levels in 28 free-living subjects with T2DM as: TEE 2453 kcal/day; PAD 69 min/day; and 5349 steps/day, which they considered low. This lower level of physical activity than in our present diabetes patients was probably due to their older age (+8 years) and the fact that they were also being treated with biphasic insulin twice a day, which may have limited their daytime physical activity.

The inverse relationship between steps/day and BMI has been noted in previous studies of adults with [8,13] and without [14] diabetes. Although walking and running are the most common forms of physical activity, some forms of activity (such as upper-body physical exercise, carrying heavy loads and scrubbing/cleaning activities) may be underestimated by assessing only steps/day. However, data reporting the relationship between other physical-activity parameters (AEE and PAD) and BMI are scanty. Jakicic et al. [13] reported on the activity patterns of obese adults with T2DM in the Look AHEAD (Action For Health in Diabetes) study, using the RT3 triaxial accelerometer. They found that those in the higher categories of BMI had shorter-duration bouts of activity and lower METs per min.

Some limitations of our study must be borne in mind. Although SWA-determined TEE and AEE have been well validated, further studies are still needed to confirm the accuracy of step counts and PAD. Also, the recruitment of people with T2DM through outpatients services at university hospitals may have selected a non-representative sample of the diabetic population and could therefore limit the generalizability of our present findings. In addition, as our study was a cross-sectional analysis, it was not possible to determine whether the decreased physical-activity indicators led to overweight and obesity or whether the weight gains caused the physical-activity indicators to decrease. Both mechanisms are probably involved. Nevertheless, in this first published study comparing SWA-determined physical activity in free-living T2DM adults with a control group, it was found that physical-activity parameters (steps/day, AEE and PAD) and BMI had a significant inverse relationship that persisted even after adjustments for gender, age, employment status and diabetes.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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