Original Article (short paper)

Type 2 diabetes, healthcare expenditures and its correlation with anthropometric factors and physical activity: 18-month follow-up in a Brazilian city

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Abstract — Aims: To compare the profile of adults attended at primary care level of the Brazilian National Health System according to occurrence of T2DM during 18 months of follow-up. **Method**: Longitudinal study carried out with 316 adults. T2DM and PA were assessed by questionnaires. Measurements of weight, height and waist circumference (WC) were also performed. Healthcare expenditures were based on the demand of services registered in medical records. Analysis of variance (ANOVA) with Tukey's post hoc test was used, as well as their similar for non-parametric variables. Spearman's correlation coefficient analyzed the relationship between variables. All analyzes were performed using the statistical software BioEstat (release 5.0) and the significance level was set at p-value < 0.05. **Results:** Patients with T2DM at baseline showed higher values of WC, BMI, nursing appointments, customer services, medication, total cost and lower values of PA when compared to patients T2DM-free. Patients who developed T2DM during the follow-up presented higher values of WC, screening, pharmacy frequency, medications and total cost when compared to individuals without T2DM. Being in the highest quartile of PA did not change the costs of health services among patients T2DM-free. Healthcare expenditures were positively correlated to BMI among participants T2DM-free and with T2DM at baseline. **Conclusion:** Participants with T2DM and participants who developed T2DM during the follow-up showed higher values of BMI, WC, healthcare expenditures and were less active when compared to participants T2DM-free. Healthcare expenditures were positively correlated with BMI among participants with T2DM at baseline and T2DM-free.

Keywords: diabetes mellitus, chronic disease, public health, exercise, body mass index, body weights and measures.

Introduction

Type 2 diabetes mellitus (T2DM) is a chronic disease characterized by dysfunction in the metabolism of carbohydrates[1]. In 2015 the global prevalence in adults aged 20 to 79 years old was 8.8% (~415.000 people), and estimation of 2014 indicate an increase of this rate to 10.4%[2]. In developing nations, such as Brazil, T2DM affects 13 million people, representing 6.9% of the overall population[3], generating expenditures to the National Health System with treatment and prevention of this disease[4].

The treatment for T2DM during primary health care is particularly relevant because effective actions in this specific level can prevent the occurrence of hospitalizations and the development of comorbidities related to the disease[5-7]. T2DM prevalence and its costs rise with aging[8], denoting significant concern due to the increase of life expectancy worldwide[9]. Also, the economic burden of T2DM is enlarged due to its association with absenteeism and premature disability[10].

Physical activity (PA) is an important non-pharmacological strategy related to prevention and treatment of T2DM[11], as well as mitigation of costs in primary care[9,12]. Therefore, the rationale of this research is to analyze whether PA can impact the development of T2DM among adults, aiming to prevent and combat T2DM, especially among those attended by public healthcare system.

Thus, the aim of this study was to compare the anthropometric profile, blood pressure, PA and healthcare expenditures of adults attended at primary care level of the Brazilian National Health System according to occurrence of T2DM during 18 months of follow-up.

Material and Methods

Sample

The study is based on data from a longitudinal study conducted in two Basic Healthcare Units (BHU) in the city of Presidente Prudente (~200,000 inhabitants), Western region of Sao Paulo state, Brazil. The cohort study evaluates cost-effectiveness of different types of treatment among adults assisted in the primary care level. The sample included adult users of primary care facilities of the Brazilian National Health System. The study was approved by the Committee for Ethics Research of the Sao Paulo State University (process: 241291/2013), campus of Presidente Prudente, and all subjects signed a standard consent form. Data collected at baseline (September/2013 to March/2015) was used to write this manuscript.

The BHU involved in the study were selected by the Department of Health of the city, taking into account the location (two distinct neighborhoods) and the number of users (prioritizing the largest BHUs). During a four-week period (September 2013), researchers invited all individuals who were at the BHU for medical appointments or medication to participate in the study, performing the following steps: (i) explanation of the objectives and procedures of the research; (ii) inclusion criteria; (iii) sign the consent form; and (iv) interview/anthropometric measurements.

Inclusion criteria were defined as: i) age $\geq$ 50 years; ii) register for at least one year at the BHU; iii) have active registration of healthcare service (have performed at least one medical visit in the past six months). Individuals not meeting the inclusion

criteria were excluded from the statistical analyzes. At baseline, the sample was composed of 523 patients.

Occurrence of T2DM

The presence of T2DM was reported using a chronic diseases questionnaire[13], which contains information about: i) diagnosis of chronic diseases; ii) time of diagnosis; and iii) use of medication.

Healthcare Expenditures

Healthcare expenditure of each participant was estimated including all items registered in the medical records during the last 12 months prior to the initial interview. Healthcare expenditures consisted of medication dispensed, laboratory tests performed, number of appointments (medical, nursing and physical therapy), and screening before and after medical appointments. As services of management and operation of the BHU we consider: frequency at pharmacy (withdrawal medication) and costs of customer services [manpower required to service activities (reception) and electricity, water and telephone consumption]. To transform the procedures in Brazilian currency (R$), the city health department provided standard tables of reimbursement services for the follow-up period.

Habitual Physical Activity

The level of PA was estimated using the questionnaire developed by Baecke, Burema, Frijters[14], whose translation and validation for the Brazilian population was performed by Florindo, Latorre, Jaime, Tanaka, Zerbini[15], (composed of 16 questions scored on a 5-points Likert scale, ranging from never to always/very often), which considers three domains of PA: occupational, sports and leisure-time. The PA level is calculated by specific equations[14] and is expressed as scores for each PA domain (higher score denotes higher PA) and the sum of all domains constitutes the overall PA. Additionally, the sample was divided into percentiles and categorized as above ($\geq$ P75) or below ($<$ P75) the highest quartile of habitual PA.

Potential confounders

Body mass index (BMI) was calculated using measurements of weight and height[16] and obtained by dividing weight by squared height (kg/m^2). Obesity was defined as BMI $\geq$ 30 kg/m^2. Measurements of waist circumferences (WC) were collected to assess abdominal obesity, with cutoff points set at 102 cm for men and 88 cm for women[17]. Economic status was assessed by specific and previously validated Brazilian questionnaire (ABEP, 2010), which estimates the family income and includes the level of formal education. Blood pressure was measured using automatic oscillometric device (Omron HEM-742 model) and followed the VI Brazilian Guidelines on Hypertension[18].

Statistical analysis

Descriptive statistics were expressed by mean and standard deviation. The analysis of variance (ANOVA) was used to compare groups and Tukey's post hoc test detected differences between groups. Data of healthcare expenditures were examined with non-parametric analysis. Spearman's correlation coefficient analyzed the relationship between variables. Statistical analyzes were performed using the statistical software BioEstat (release 5.0) and the significance level was set at p-value < 0.05.

Results

At baseline, the sample consisted of 523 adults of both sexes (161 men [29.4%] and 362 women [70.6%]). The most prevalent diseases were arterial hypertension (60.80%), followed by arthritis/arthrosis (44.93%), and dyslipidemia (26.87%). Regarding healthcare expenditures, no significant difference was observed when comparing men and women. On the other hand, when considering the age of the participants, a positive correlation was observed for medication dispensed ($r = 0.121$; $p = 0.006$) and negative correlation for medical appointment ($r = -0.096$; $p = 0.030$).

After 18 months of follow-up, the overall sample was composed of 316 adults of both sexes (93 men [30.8%] and 223 women [69.1%]). Regarding to T2DM status during the follow-up, 21.8% of participants had T2DM at baseline (n = 69), 75% of the subjects remained T2DM-free (n = 237) and 3.2% of the subjects developed T2DM (n = 10).

At baseline, the group composed of participants with T2DM and the group of participants that developed T2DM during the follow-up presented higher values of WC compared to participants T2DM-free. Additionally, the group of participants with T2DM had higher BMI values compared to participants T2DM-free. Score of overall PA was significantly lower in participants with T2DM when compared to participants T2DM-free (**Table 1**).

Table 1. Baseline characteristics of the participants according to T2DM status (Presidente Prudente/SP, 2014).

Variables	T2DM-free	T2DM at baseline	Developed T2DM	*p*-value*
	Mean (SD)	Mean (SD)	Mean (SD)	
Age	61.20 (9.17)	63.90 (9.74)	62.57 (9.26)	0.400
WC	93.08 (14.14)	103.10 (10.89)[a]	98.28 (12.25)[a]	**0.003**

Weight	72.19 (15.06)	79.20 (10.18)	74.10 (15.91)	0.263
BMI	28.91 (5.2)	33.30 (4.69)[a]	29.96 (5.78)	**0.021**
Occupational PA	1.99 (0.92)	1.60 (1.17)	2.11 (0.06)	0.244
Sports	1.50 (0.66)	1.20 (0.42)	1.48 (0.65)	0.358
Leisure-time PA	1.88 (0.72)	1.40 (0.51)	1.78 (0.72)	0.093
Overall PA	6.11 (1.47)	4.9 (1.72)[a]	6.0 (1.51)	**0.041**
SBP	137.56 (21.81)	146.80 (33.06)	140.97 (21.83)	0.272
DBP	79.81 (12.42)	81.70 (12.29)	77.74 (10.0)	0.385
ES	19.01 (5.06)	17.90 (3.24)	18.81 (4.27)	0.759

Notes: *: ANOVA; SD: standard deviation, a significant differences compared to T2DM-free group; WC: Waist Circumference; BMI: Body Mass Index; PA: Physical Activity; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; ES: Economic status.

Regarding healthcare expenditures, we found that the group with T2DM at baseline and individuals who developed T2DM during the follow-up presented higher expenditures when compared with participants T2DM-free (**Table 2**). It is worth noting that the annual average costs with medication and total per individual with T2DM was ~ 2 times (R$ 123.99 *versus* R$ 61.61) and ~ 1.39 times (R$ 317.19 *versus* R$ 225.09) higher, respectively, when compared to adults T2DM-free. For participants that developed T2DM during the follow-up, the difference was ~ 1.6 times for medication (R$ 98.10 *versus* R$ 61.61) and total of healthcare services (R$ 368.74 *versus* R$ 225.09), respectively (**Table 2**).

Table 2. Healthcare expenditures of the participants according to T2DM status (Presidente Prudente/SP, 2014).

H.E. (R$)	T2DM-free	T2DM at baseline	Incidence of T2DM	*p*-value*
	Median (IR) Mean (SD)	Median (IR) Mean (SD)	Median (IR) Mean (SD)	
Medical appointment	77.60 (80.60) 98.20 (78.42)	87.30 (68.00) 107.07 (86.01)	117.90 (78.90) 119.14 (42.56)	0.083
Nursing appointment	2.85 (6.36) 5.48 (17.84)	7.09 (17.86)[a] 16.12 (26.42)	5.70 (8.51) 7.0 (7.48)	**0.001**
Screening	4.38 (3.65) 4.79 (3.02)	4.38 (3.83) 4.73 (3.25)	6.93 (4.38)[a b] 7.05 (3.08)	**0.040**
Physical therapy appointment	(0.0) 2.09 (5.73)	0.0 (0.0) 1.31 (4.52)	0.0 (0.0) 1.74 (5.05)	0.725
Frequency at pharmacy	5.50 (6.0) 5.21 (3.69)	6.50 (4.0) 5.85 (2.77)	7.25 (4.0)[a] 7.29 (2.80)	**0.039**
Customer services	17.08 (24.60) 25.51 (25.15)	27.45 (30.0)[a] 36.29 (45.71)	21.96 (17.90) 27.65 (16.19)	**0.006**
Laboratory test	(37.99) 22.17 (51.61)	0.0 (44.63) 21.37 (33.94)	13.79 (91.01) 101.19 (247.65)	0.239
Medication dispensed	34.82 (64.40) 61.61 (91.54)	71.02 (119.82)[a] 123.99 (140.51)	65.94 (63.0)[a] 98.10 (107.50)	**0.001**
Overall cost	190.78 (191.09) 225.09 (167.37)	258.87 (235.54)[a] 317.19 (223.66)	311.67 (216.12)[a] 368.74 (245.37)	0.001

Notes: *: Kruskal-wallis; IR: standard deviation, a significant differences compared to T2DM-free group; b significant differences compared to T2DM at baseline group; H.E.: healthcare expenditures; R$: Brazilian currency.

Furthermore, it was observed that participants with T2DM at baseline and individuals who developed T2DM during the follow-up presented higher healthcare expenditure when compared to participants T2DM-free, independently of being located in the highest quartile of PA (**Table 3**). Of the 10 individuals who developed T2DM during the follow-up, only one was classified

as ≥ P75 of overall PA and data are not shown in table 3. We highlight that being in the highest quartile of PA did not change the costs of healthcare services among individuals with T2DM.

When analyzing correlations between variables according to T2DM status, it was found that among participants T2DM-free, healthcare expenditures were positively correlated to BMI, while BMI was also positively correlated to occupational PA. Systolic blood pressure and occupational PA were negatively correlated, while chronological age was negatively correlated to occupational and overall PA (**Table 4**). In the group composed of participants who developed T2DM during the follow-up, age and leisure-time PA were consistently correlated (**Table 5**).

On the other hand, among participants with T2DM at baseline, BMI was positively correlated to higher healthcare expenditures, occupational PA and negatively correlated to leisure-time PA. WC was negatively correlated to leisure-time PA (**Table 6**).

Table 3. Healthcare expenditures of the participants according to T2DM status and habitual physical activity (Presidente Prudente/SP, 2014).

H.E. (R$)	T2DM-free Median (IR) Mean (SD)		T2DM at baseline Median (IR) Mean (SD)		Incidence T2DM Median (IR) Mean (SD)	*p*-value*
	≥ P75 Overall PA N=74	< P75 Overall PA N=164	≥P75 Overall PA N=18	<P75 Overall PA N=48	< P75 Overall PA N=11	
Medical appointment	67.90 (67.90) 90.00 (71.10)	87.30 (85.50) 101.90 (81.44)	77.60 (65.60) 93.27 (64.93)	91.57 (68.30) 112.25 (92.76)	119.40 (72.40) 122.91 (42.48)	0.195
Nursing appointment	2.15 (5.72) 4.13 (6.63)	2.85 (5.70) 6.09 (21.02)	6.43 (11.97) [a] 8.16 (7.86)	7.16 (21.51) [a,b] 19.10 (30.16)	7.16 (8.03) 7.64 (7.49)	**0.001**
Screening	4.38 (2.92) 4.59 (2.63)	4.38 (4.38) 4.88 (3.19)	3.48 (3.83) 3.85 (2.10)	4.74 (4.38) 5.03 (3.55)	7.30 (5.11) 7.36 (3.03)	0.082
Physical therapy appointment	0.0 (0.0) 2.37 (6.18)	0.0 (0.0) 1.96 (5.52)	0.0 (0.0) 1.84 (5.73)	0.0 (0.0) 1.70 (4.83)	0.0 (0.0) 1.42 (4.72)	0.962
Frequency at pharmacy	5.25 (6.00) 5.11 (3.63)	5.50 (6.00) 5.25 (3.72)	6.50 (4.00) 5.50 (2.91)	6.50 (3.00) 5.98 (2.73)	7.50 (4.00) 7.50 (2.83)	0.171
Customer services	15.86 (18.80) 22.28 (18.91)	18.18 (26.40) 26.97 (27.44)	25.12 (27.50) 27.79 (20.08)	27.45 (29.70) [a,b] 39.48 (50.02)	23.18 (16.80) [a] 29.28 (15.92)	**0.016**
Laboratory test	0.0 (44.20) 28.36 (68.07)	0.0 (23.37) 19.37 (42.10)	0.0 (10.02) 11.82 (23.39)	0.0 (56.40) 24.96 (36.70)	0.0 (58.16) 30.61 (41.40)	0.100
Medication dispensed	32.11 (58.33) 50.51 (62.74)	35,27 (71.19) 66.48 (101.93)	69.26 (110.13) [a,b] 91.52 (75.53)	72.32 (139.37) [a,b] 136.17 (157.12)	66.55 (43.57) [a,b] 104.93 (75.53)	0.001
Overall cost	171.54 (181.79) 207.69 (156.81)	203.84 (187.33) 232.94 (171.81)	251.71(165.91) [a] 243.77 (122.29)	272.80 (267.84) [a,b] 344.72 (246.85)	290.63 (227.01) [a] 311.67 (152.41)	0.001

Notes: *: Kruskal-wallis; IR: standard deviation, [a] significant differences compared to T2DM-free group and ≥P75 Overall PA; [b] significant differences compared to T2DM-free group and <P75 Overall PA; H.E.: healthcare expenditures; R$: Brazilian currency.

Table 4. Correlates of healthcare expenditures and physical activity domains among T2DM-free participants (Presidente Prudente, SP, Brazil, 2014).

Variables	Age	WC	Weight	BMI	SBP	DBP	ES
	rho	rho	rho	rho	rho	Rho	rho
Healthcare expenditures	-0.022	0.071	0.097	**0.165***	-0.052	0.061	-0.094
Occupational PA	**-0.256***	-0.013	0.020	**0.164***	**-0.136***	0.086	0.037
Sports	-0.060	0.048	0.112	0.125	-0.037	-0.086	-0.022
Leisure-time PA	0.015	0.011	0.044	0.016	0.047	-0.082	-0.109
Overall PA	**-0.155***	-0.046	0.024	0.081	-0.062	0.016	-0.043

Notes: * p-valor <0,05; rho: Spearman correlation coefficient; WC: Waist Circumference; BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; ES: Economic Status; PA: Physical Activity.

Table 5. Correlates of healthcare expenditures and physical activity domains among participants who developed T2DM during 18-months follow-up (Presidente Prudente, SP, Brazil, 2014).

Variables	Age	WC	Weight	BMI	SBP	DBP	ES
	rho	rho	rho	rho	rho	rho	rho
Healthcare expenditures	-0.491	0.024	0.455	0.176	0.127	0.409	-0.068
Occupational PA	-0.289	-0.185	-0.171	-0.039	-0.026	0.434	-0.312
Sports	0.348	0.175	0.0	0.087	-0.087	-0.306	-0.133
Leisure-time PA	**-0.711***	0.036	0.426	0.142	-0.213	0.250	0.109
Overall PA	-0.271	-0.152	0.006	0.050	0.038	0.320	-0.439

Notes: * p-valor <0,05; rho: Spearman correlation coefficient; WC: Waist Circumference; BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; ES: Economic Status; PA: Physical Activity.

Table 6. Correlates of healthcare expenditures and physical activity domains among participants with T2DM at baseline (Presidente Prudente, SP, Brazil, 2014).

Variables	Age	WC	Weight	BMI	SBP	DBP	ES
	rho	rho	Rho	Rho	rho	rho	rho
Healthcare expenditures	0.028	0.201	0.098	**0.239***	0.023	0.089	-0.157
Occupational PA	-0.188	0.226	0.170	**0.257***	-0.161	-0.172	0.222
Sports	-0.009	0.112	0.200	0.131	-0.029	0.082	0.116
Leisure-time PA	-0.025	**-0.292***	-0.206	**-0.305***	0.066	0.035	0.121
Overall PA	-0.054	0.049	0.163	0.094	-0.102	-0.020	0.171

Notes: * p-valor <0,05; rho: Spearman correlation coefficient; WC: Waist Circumference; BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; ES: Economic Status; PA: Physical Activity.

Discussion

This study analyzed the profile of adult users of the Brazilian National Health System and identified different patterns of body composition, PA levels and healthcare expenditures according to T2DM status. It was also found correlations between healthcare expenditures and body mass index, as well as between different levels of PA, body composition and age.

At baseline, we found high prevalence of arterial hypertension, osteoarticular diseases and dyslipidemias. Our results are not different than findings from a population-based cohort study, which assessed more than 41,000 Brazilian individuals aged 60 or older and found similar prevalence of arterial hypertension (53.3%) and osteoarticular diseases (24.2%)[19]. Additionally, we did not find differences regarding healthcare expenditures when comparing men and women. However, it has been observed that older patients present higher costs on medications and lower on medical appointment. The scientific literature has shown that female sex is a relevant determinant of healthcare services use[20], as well as the increase in chronological age[10]. These findings can be explained by the coexistence of chronic diseases by these populations[4,21].

At baseline, participants with T2DM and participants who developed T2DM during the 18-months of follow-up showed higher values of WC and BMI. The Brazilian Society of Diabetes (2014-2015)[22] shows that most patients with T2DM presents overweight or obesity, factor explained by alterations in fat mass and insulin action since early life[23,24]. The association between T2DM and obesity is mainly due to problems with insulin action and/or secretion, factor that contributes to fat accumulation on liver and skeletal muscles, reducing the capacity to metabolize glucose and exacerbating insulin resistance[1,22]. Furthermore, abdominal fat plays a fundamental role on abnormal metabolism of glucose[25] mainly due to the increased amount of circulating fatty acids that directly affects glucose transport[22].

We also found that participants with T2DM were less active than participants who were T2DM-free. Physical inactivity is responsible for 6-10% of all non-communicable diseases, being related to 7% of all cases of T2DM[26]. On the other hand, PA

interventions have confirmed to be as efficient as drug treatment to control physiological complications of T2DM[27-29] and protect against comorbities[30]. PA is able to improve insulin sensitivity, increase glucose uptake in muscle and fat cells, and intensify the uptake of blood glucose by insulin non-dependent mechanisms, which are activated by muscle contraction, enhancing glycemic regulation[16].

Regarding healthcare expenditures, the present study found that participants with T2DM at baseline presented, in general, higher expenditures with healthcare services when compared to participants T2DM-free, presenting costs almost two times (100%) higher with medication and ~ 1.39 times (41%) higher with total healthcare services. In the national literature, there are only a few studies that present monetary costs of healthcare expenditures in diabetic and non-diabetic patients, although it is known that this disease is responsible for increasing the use of healthcare services due to the need for periodic medical consultations, laboratory tests and continuous-use medication[31]. Similarly, increased healthcare costs in diabetic patients have been observed in developing and developed countries[32]. In the U.S., a diabetic adult costs ~ 2.3 times more than an adult without the disease[33].

Additionally, our findings regarding the higher costs with healthcare services in individuals who developed T2DM agree with results found in the literature. A study conducted in Sweden analyzed ~ 39,000 individuals who developed diabetes, and showed that the annual use of health resources almost doubled in the first year after the diagnosis of the disease[34], and the largest amount (43-59%) concerned primary care costs[35].

We highlight the fact that public expenditures attributed to diabetes account for 11% of total expenditures for public health worldwide (67.32 billion dollars)[36], and patients with diabetes cost 69% more than patients with other chronic diseases[37].

At the same time, it was observed that, independently of PA level, individuals who developed T2DM presented higher costs with healthcare services when compared to individuals T2DM-free. In addition, among diabetic individuals, the level of PA was not able to reduce healthcare costs. A previous study carried out with a similar population compared sedentary and active diabetics, and even not finding statistical differences (p-value = 0.554), the authors showed an economy with basic healthcare procedures of approximately seven thousand Reais per 100 people[12].

Similarly, a study with 121 individuals aged 32-75 years, users of the public health system, observed that physically active adults with T2DM were 81% less likely to have expenditures with treatments for other diseases and 74% less likely to have expenditures with medical consultations when compared to sedentary adults with T2DM[9]. A possible explication for our finding might be the contribution of occupational domain in the overall PA scores, so individuals classified in the highest quartile of habitual PA may not be those engaged in exercise, which is often responsible for improving health and reducing the deleterious effects of T2DM.

At the end of the study, participants with T2DM had lower levels of occupational PA, higher age and blood pressure. Regarding healthcare expenditures, it was found to have a correlation with BMI. The lower levels of PA among elderly patients are supported by the Brazilian Health National Research (2013)[38], which denotes it as a characteristic of the Brazilian population. In addition, scientific evidence indicates that lower levels of PA are associated with higher blood pressure values[39]. However, PA plays a role as antihypertensive by decreasing peripheral vascular resistance and increasing vasodilatation[40].

Furthermore, lower levels of PA were associated with obesity[41]. It is well known that obesity increases the prevalence of chronic diseases and, subsequently, the demand for health services and its costs[42]. Recently, a study showed that obese and inactive individuals presented higher costs with medical consultations, use of medicines and total expenditures on healthcare when compared to individuals who did not have these variables associated[43].

When analyzing the group of participants with T2DM, anthropometric variables such as WC and BMI were negatively related to leisure-time PA, while BMI was related to healthcare expenditures. In the scientific literature, PA has been associated with reduced body weight and body fatness in patients with T2DM[44,45], as well as it is related to lower healthcare expenditures. During primary care, T2DM patients that are physically active are US$1,600 less expensive than sedentary T2DM patients[12], denoting that PA promotion at primary care can improve health outcomes and mitigate healthcare costs, fact that can be explained by the decline of medical care due to improvement in self-perception resulting from the exercise[46].

As limitations we identify the use of questionnaires to assess PA levels and the occurrence of T2DM, the assessment of patients from only two BHU of the city, so inferences for other BHU should be made with caution (patients could present different profiles), and the selection of the sample was not randomized.

Finally, it is noteworthy to mention that simple and low cost measurement tools were able to identify potential risk factors for incidence of T2DM in the context of primary care, findings that enable the prevention and cost-effectiveness of T2DM treatment. Thus, from a public health perspective, increasing the promotion of healthy lifestyle interventions in the healthcare system and throughout our societies is urgently needed. Thus, we emphasize the need for intervention researches assessing the effects of exercise on deleterious effects of T2DM, along with the possible reduction of healthcare expenditures related to this disease.

Conclusion

It was possible to conclude that participants with T2DM and participants who developed T2DM during the follow-up showed higher values of BMI, WC, healthcare expenditures and were less active when compared to participants T2DM-free. Among participants with T2DM, being in the highest quartile of PA did not change the costs with healthcare services. Healthcare expenditures were correlated with BMI among participants with T2DM at baseline and T2DM-free.

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