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original article

# Behavioral and biological correlates of medicine use in type 2 diabetic patients attended by Brazilian public healthcare system

## *Determinantes biológicos e comportamentais do uso de medicamentos em diabéticos do tipo 2 atendidos no Sistema Único de Saúde*

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**Abstract** – The relationship between physical activity and the use of medicines is not clear. The purpose of this study was to investigate this relationship between the level of physical activity and the use of medications by type 2 diabetic patients who were attended in the Brazilian public healthcare system. The sample was composed of 121 Brazilian diabetic patients, of both genders, attended by the public healthcare system. Body fat (estimated by anthropometry and bioelectrical impedance), physical activity (measured by Baecke's questionnaire), and the participant's use of medicines (during the 15 days before evaluation) were assessed. There was a relationship between the use of medicines and: gender ($r = 0.18$; $p = 0.045$), body mass index (BMI) ($r = 0.22$; $p = 0.012$), waist circumference ($r = 0.19$; $p = 0.029$), body fat percentage ($r = 0.21$; $p = 0.016$), age ($r = 0.23$; $p = 0.009$), and level of physical activity ($r = -0.22$; $p = 0.012$). Linear regression included in the multivariate model only age ($\beta = 0.718$; $p = 0.057$), BMI ($\beta = 0.057$; $p = 0.022$), and level of physical activity ($\beta = -0.176$; $p = 0.044$). In conclusion, physical activity decreases medicinal use independent of age or obesity.

**Key words** Brazil; Costs; Obesity; Physical activity; Type 2 diabetes.

**Resumo** – *A relação entre atividade física e consumo de medicamentos não é clara. Assim, o objetivo do estudo foi investigar a relação entre nível de atividade física e uso de medicamentos em diabéticos tipo 2 atendidos pelo Sistema Único de Saúde. A amostra foi composta por 121 diabéticos do tipo 2 de ambos os sexos atendidos pelos sistema público de saúde. Gordura corporal (antropometria e bioimpedância elétrica), atividade física (Questionário de Baecke) e uso de medicamentos (15 dias prévios a avaliação) foram avaliados. Houve relação entre uso de medicamentos e sexo ($r = 0.18$; $p = 0.045$), índice de massa corporal ($r = 0.22$; $p = 0.012$), circunferência de cintura ($r = 0.19$; $p = 0.029$), percentual de gordura ($r = 0.21$; $p = 0.016$), idade ($r = 0.23$; $p = 0.009$) e atividade física ($r = -0.22$; $p = 0.012$). A regressão linear incluiu no modelo apenas idade ($\beta = 0.718$; $p = 0.057$), IMC BMI ($\beta = 0.057$; $p = 0.022$) e atividade física ($\beta = -0.176$; $p = 0.044$) no modelo multivariado. Conclui-se que a prática de atividade física diminui uso de medicamentos independente da idade e obesidade.*

**Palavras-chave**: *Atividade física; Brasil; Custos; Diabetes mellitus; Obesidade.*

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## INTRODUCTION

Physical inactivity is a current concern for the western world and substantially increases the risk of chronic disease like type two diabetes mellitus (T2DM)[1]. T2DM has been identified in approximately 7.6% of Brazilian adults aged between 30 and 69 years[2], and this elevated occurrence of chronic disease is related to higher public healthcare costs[3]. It is projected that these costs will reach 302 billion dollars by 2025[4].

Sedentary people typically have high levels of body fat and a tendency to dyslipidemia and arterial hypertension[1,5]. Scientific literature shows consistent evidence indicating that practicing regular physical activity prevents and treats chronic diseases such as T2DM[1,5]. In the developing world, on the other hand, it is not clear if a program of physical activity reduces medicinal use in those diabetic patients attended to in the public healthcare system. Nor is it clear if regular physical activity might be independent of adiposity and ageing.

Therefore, the purpose of this study was to investigate the correlation (if it exists) between the level of physical activity and the use of medicine by type 2 diabetic patients attended by the Brazilian public healthcare system.

## METHODS

### Sample

The sample was composed of 121 diabetic patients, of both genders, from two of the 17 Basic Healthcare Units (BHUs) located in the city of Bauru, Brazil from January to February of 2009. Because surgical and complex procedures are referred to hospitals, the BHU consists of medical units with preventive aims in which there is a variety of health professionals who attend a specific geographical region of the city. BHUs are maintained exclusively by governmental funds and make up only a portion of the extensive Brazilian Public Healthcare System. In the BHU, medication is available for treating diabetes mellitus and arterial hypertension. The participating patients were contacted by phone and met the following inclusion criteria: (i) previously diagnosed type 2 diabetes mellitus; (ii) at least one year of BHU medical records accumulated before the beginning of the study; (iii) an age less than 75 years. The study protocol was reviewed and approved by the Ethics Committee of Human Experimentation of the Paulista State University – UNESP, Rio Claro Campus. (Process: 6898, November 12, 2008). All patients signed an informed written consent form.

### Independent variables

The characteristics of sex, age, and race of the prospective participants were adopted as independent variables. The presence of some diseases was self-reported during the interview and then confirmed by the patients' BHU medical records (e.g., hypercholesterolemia, arterial hypertension, various types of cancer, low back pain, or osteoporosis). Any current diet prescribed

by a nutritionist and targeting either glycemic control or weight loss was analyzed and considered a categorical (yes or no) variable. A patient's economic condition revealed by the previously validated questionnaire[6] and which generates a score for economic level (the higher the score, the higher the economic condition).

Various adiposity indexes were also considered. The body mass index (BMI [kg/m²]) was calculated using the values of body weight and height[7]. Body fat percentage (%BF) was estimated by bioelectrical impedance using a portable Bioelectrical Impedance Analysis device (BIA Analyzer -101Q, RJL Systems, Detroit, EUA) and following validated protocols for measurements[8]. Values of hip and waist circumference (WC) were also collected according to validated protocols[7]. And waist-to-hip ratios (WHR) were calculated.

Smoking habits were assessed by virtue of the cardiovascular risk questionnaire of the American Heart Association[9], and a categorical variable was designed (value 1: non-smoker; value 2: former smoker; value 3: < 10 cigarettes per day; value 4: 10-20 cigarettes per day; value 5: 20-30 cigarettes per day; value 6: ≥ 30 cigarettes per day). Additionally, the last result of the patient's fasting blood glucose exam was noted, measured in mg/dL and recorded in the patient's BHU medical records.

## Medicine use

Through face-to-face interviews, and a previously developed questionnaire[10], the diabetic patients reported their medicine use over the previous 15 days (medicines acquired outside BHU). Only medicines of regular use were taken into account (e.g. drugs for treatment of cardiac complications, arterial hypertension, osteoporosis, or dyslipidemia).

## Physical activity level

A previously validated questionnaire[11] was used to assess the level of physical activity. This 16 point questionnaire was based on a Likert scale, and the patient's practice of physical activity was analyzed over three domains: work, leisure, and sports. The questionnaire generates a specific score for each domain and the sum of all areas constitutes a patient's level of physical activity. For the present study only sport activity was included.

## Statistics

Numerical variables were presented as mean and standard-deviation. Student t test compared the independent variables according to the number of medicines used (< 3 units versus ≥ 4 units). Spearman's and Pearson's correlation coefficients were used to verify the relationship between the number of medicines and the independent variables. Finally, independent variables that reached statistical significance ($p < 5\%$) in the univariate model were inserted into the multivariable model (linear regression), in which adjusted coefficients (β) were produced. The Statistical Package for the Social Sciences software (SPSS) version 17.0 was used in all analyses with the significance set at $p < 5\%$.

## RESULTS

Mean usage of medicines was 3.62±1.8 units per patient (ranging from zero to 10 units). Patients with higher medicine consumption showed a greater age (p = 0.05), BMI (p = 0.003), WC (p = 0.006) and %BF (p = 0.012). Further, these same patients revealing higher medicine usage presented lower physical activity levels (p = 0.040). Fasting glucose values, even without being statistically significant, were higher in diabetic patients who revealed a higher consumption of medicines (Table 1).

There was a positive and significant correlation between medicine use and gender (r = 0.18; p = 0.045), BMI (r = 0.22; p = 0.012), WC (r = 0.19; p = 0.029) and %BF (r = 0.21; p = 0.016) (Table 2).

**Table 1.** General characteristics of diabetic patients stratified according to medicine use (Brazil, n = 121).

| Variables | Medicine use over the previous 15 days | | P |
|---|---|---|---|
| | < 3 units (n = 66) | ≥ 4 units (n = 55) | |
| | Mean (SD) | Mean (SD) | |
| Age (years) | 58.6 (9.4) | 61.8 (8.1) | 0.050 |
| BMI (kg/m$^2$) | 28.9 (5.1) | 32.6 (7.5) | 0.003 |
| WC (cm) | 97.7 (12.4) | 104.4 (14.1) | 0.006 |
| WHR (m) | 0.95 (0.08) | 0.95 (0.07) | 0.763 |
| %BF (%) | 33.4 (8.9) | 38.1 (10.8) | 0.012 |
| PAL score | 6.87 (1.95) | 6.17 (1.71) | 0.040 |
| Glucose (mg/dL) | 154.9 (47.9) | 177.1 (92.3) | 0.094 |

SD = standard-deviation; WC = waist circumference; BMI = body mass index; WHR = waist to hip ratio; %BF = body fat percentage measured by bioelectrical impedance; PAL score = physical activity score provided by Baecke questionnaire.

**Table 2.** Correlation (r) between medicine use and independent variables in type 2 diabetes mellitus patients (Brazil, n = 121)

| Dependent variable | Groups of Independent Variables | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | I – General characteristics | | | II – Body composition | | | | III – Behavioral | | | IV – Metabolic |
| | Gender* | Race* | Income§ | WC (cm)§ | BMI (kg/m$^2$)§ | WHR (m)§ | %BF§ | Smoke* | Diet* | PAL§ | Glucose (mg/dL)§ |
| Medicines | 0.18 | 0.00 | -0.12 | 0.19 | 0.22 | -0.03 | 0.21 | -0.11 | -0.04 | -0.22 | 0.19 |
| p | 0.045 | 0.939 | 0.190 | 0.029 | 0.012 | 0.719 | 0.016 | 0.201 | 0.644 | 0.012 | 0.836 |

§= Pearson's correlation; *= Spearman's correlation due categorical variables; Medicines = amount of medicines used over the previous 15 days; WC = waist circumference; BMI = body mass index; WHR = waist to hip ratio; %BF= body fat percentage measured by bioelectrical impedance; PAL score = physical activity score provided by Baecke questionnaire.

The higher physical activity level was inversely related to use of medicine (r = -0.22; p = 0.012). Additionally, there was a positive correlation between age and medicine use (r = 0.23; p = 0.009). Linear regression excluded the variables WC (β = 0.01 [$\beta_{95\%CI}$: -0.03; 0.05]; p = 0.594), %BF (β= -0.04 [$\beta_{95\%CI}$: -0.14; 0.05]; p = 0.424) and gender (β = 0.83 [$\beta_{95\%CI}$: -0.54; 2.22]; p = 0.233) of the final model, and only age (β = 0.718; p = 0.057), BMI (β = 0.057; p = 0.022), and physical activity level (β= -0.176; p = 0.044) were significantly and independently related to the number of medicines used by diabetic patients (Figure 1).

Finally, diabetic patients showed significant correlation between medicine use and self-reported arterial hypertension (r = 0.41; p = 0.001) and osteoporosis (r = 0.17; p = 0.049), but, dyslipidemia (r = 0.17; p = 0.054) and hypothyroidism (r = 0.16; p = 0.064) were marginally correlated with medicine use with these patients.

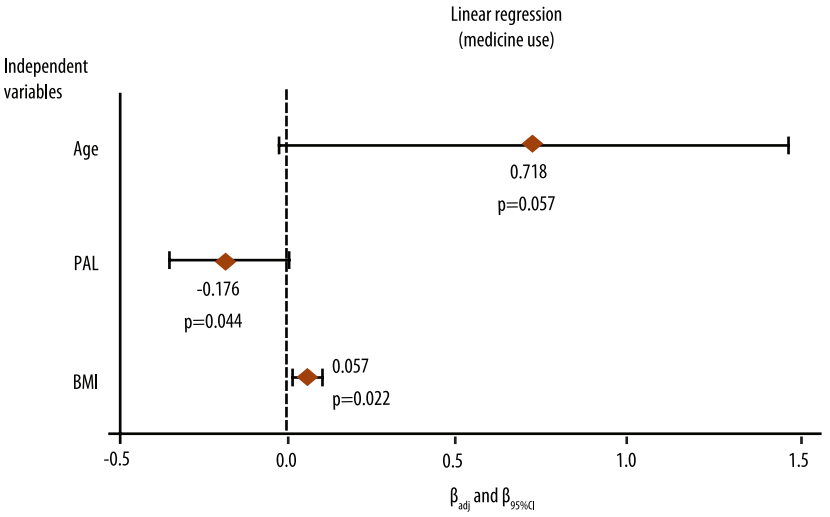


**Figure 1.** Relationship between independent variables and medicine use in type 2 diabetics.

## DISCUSSION

In the diabetic patients assessed in our study and who were patients in the Brazilian Public Healthcare System, there was a significant relationship between their use of medicine, their age, BMI, and their level of physical activity.

Body fat and BMI were positively correlated with medicine use in these diabetic patients (independent of WC and %BF as measured by bioelectrical impedance). There is a wide variety of studies assessing the relationship between adiposity and public healthcare costs, but a smaller number examines their relationship with a use of medication.

A previous study[3] suggested that in 2001 the costs associated with obesity-induced disease (for adults aged from 20 to 60 years) in the Brazilian Public Healthcare System were approximately 10 million dollars. In the present study the positive correlation between obesity and the use of medicine could be justified by the increased occurrence of other comorbidities in obese people. In fact, it is well documented that body weight control constitutes an important strategy in the prevention and treatment of many chronic diseases by hindering adipose tissue from releasing a variety of adipokines involved in different metabolic abnormalities (insulin resistance, for example) and thus related to several other diseases[12,13].

Our findings agreed with a previous study[14] that identified diabetics with arterial hypertension indicating that such subjects have higher levels of adiposity than those without arterial hypertension. Moreover, in the present study, some diseases related to obesity (dyslipidemia and arterial hypertension, for example)[12,15] positively correlated with the use of medications.

Our findings associating levels of physical activity to medicine use, agree with earlier research. A previous epidemiological study[10] found that sedentary people presented a higher consumption of medicines compared with the physically active. In the same study, additional analysis suggested that this result remains significant only when diabetic and hypertensive subjects were analyzed. Similarly, authors[16] in a prospective study involving diabetics observed that costs related to medicines decreased in more physically active diabetics. These results are all in accordance with previous data[17] suggesting that diabetic patients attended by the Brazilian Healthcare System, and who engage in regular physical activity, also report a decrease in medical costs for the treatment of other diseases.

A possible explanation for the negative correlation between physical activity and the use of medicines by diabetics could rest in the protective role of a physically active lifestyle that might prevent other diseases[1] through direct influence on both production of adipokines and hence its inflammatory processes, which are *decreased* by physical activity[18].

The present study substantiated the unsurprising finding that older patients exhibit an increased consumption of medicines. It is also well documented (and unsurprising) in the scientific literature that older people are associated with an increase in chronic diseases. Some explanations for these two findings are related to a natural reduction in muscle mass and an increase in body fat[19], which is, in turn, related to a tendency toward the development of obesity and a subsequent insulin resistance[12]. There is also the relevant fact that older people tend to engage in increasingly reduced physical activity toward the end of their lives[1,20].

The cross-sectional design and the small sample size of the present study constitute its main limitations. Thus, this relationship between physical activity and the use of medications should be analyzed in future epidemiological studies based upon prospective designs involving patients with type 2 diabetes and other chronic diseases.

## CONCLUSION

In summary, our study identified significant correlations between the practice of physical activity and lower medicinal use in type 2 diabetic patients of both genders who are patients in the Brazilian Public Healthcare System. The study also revealed, as well, a strong relationship between adiposity and a consumption of medicines. And finally, our findings revealed that the relationship between physical activity and the use of medicines are independent of age and obesity.

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