CALORIC EXPENDITURE OF DIFFERENT DOMAINS OF PHYSICAL ACTIVITY AS PREDICTORS OF THE ABSENCE OF DIABETES IN ADULTS

EXERCISE AND SPORTS MEDICINE CLINIC

ORIGINAL ARTICLE

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ABSTRACT

Background: Physical activity had a protective effect against chronic diseases and cardiovascular risk factors; however, the caloric expenditure necessary to promote diabetes prevention remains speculative. Objective: To analyze the caloric expenditure of different domains of physical activity (work, commuting, household, leisure time and total physical activity) as predictors of the absence of diabetes in adults of both sexes. Methods: This was a cross-sectional study in the town of Lauro de Freitas, Bahia, Brazil (2007 – 2008) with a sample of 522 individuals over 18 years of age; 302 female and 220 male. Receiver Operating Characteristic Curves (ROC) were constructed and the areas below them were compared. Additionally, the sensitivity and specificity to identify the best cutoff points among the different domains of physical activity and the absence of diabetes were verified. Confidence interval at 95% was used. Results: Among the different domains of physical activity analyzed, statistical significance was only found in the areas under the ROC curve for leisure time, commuting and total physical activity. Additionally, it was observed that the caloric expenditure in total physical activity ranging from 830 kcal/week and 1.774 kcal/week were the best cutoff points for predicting the absence of diabetes. Conclusion: Physical activity should be suggested at appropriate levels for individuals of both sexes to contribute to diabetes prevention.

Keywords: motor activity, health care, predictive value, ROC curve, adult.

INTRODUCTION

Physical activity is defined as any body movement produced by the skeletal musculature which results in energetic expenditure above rest levels[1], and it can be divided by the work, commuting, household and leisure time domains.

Several studies[2-6] have demonstrated that physical activity presents a protective effect against chronic diseases and cardiovascular risk factors, including diabetes, obesity, hypertension, dyslipidemias and inflammatory markers.

Physical inactivity, population ageing and high prevalence of obesity are some factors which are leading diabetes mellitus (DM) to the status of an epidemic, since according to the Brazilian Diabetes Society[7], in 1985 there was an estimation of 30 million adults with DM worldwide; this number increased to 135 million in 1995, reaching 173 million in 2002, with expectation to reach 300 million in 2030. Approximately two thirds of this population lives in developing countries where the epidemic strongly occurs, being present also among younger individuals[8].

DM patients have physical activity, use of medication and food diet as crucial part of their treatment[9]. Leisure time physical activity helps to decrease and/or keep body weight, to reduce the need for oral anti-diabetic medication, to decrease insulin resistance and to contribute to improvement of the glycemic control, which on its turn reduces the risk of the complications associated with diabetes[10]. Moreover, it has been recently demonstrated that the many physical activity domains may be considered good predictors of absence of diabetes in adult individuals[11].

Despite all the evidence, the necessary caloric expenditure and the physical activity domain which would provide higher impact to diabetes prevention remains a speculation, which broadens the relevance of studies which try to answer these questions. Wider understanding on physical activity and its benefits brings important contributions to public health, since they can work as grounding to the management of public politics which promote physical activities practice in population subgroups more affected by a physically inactive lifestyle.

Thus, the aim of this study was to analyze the caloric expenditure with total physical activity and in their different domains (work, commuting, household, leisure time) as predictors of absence of diabetes in adults of both genders.

METHODS

This was a transversal study performed in the town of Lauro de Freitas, in the northeast of Bahia state, partof the metropolitan region of Salvador, with territorial extension of 59 square kilometers. The Lauro de Freitastown had IDH of 0.771, PIB per capita of R$ 12,046.00 and estimated population of 138,240[12].

Sample

The sample calculation was based on Kisch[13], considering the following parameters: population size of 138,240 inhabitants, prevalence of active individuals of 50% based on the study conducted in the São Paulo state, Brazil[14], as well as higher prevalence amongst the variables assessed in the study, confidence level of 95% of accuracy, error of five percentage points. The sample was calculated in 500 individuals with increase of 20%, totalizing 600 adults aged 18 years or older.

The addition of 100 individuals in the minimum sample calculated expected the exclusion of the empty households, absent residents, ineligible residents, sick individuals in bed, individuals who refused to answer the questionnaire.

The sample was probabilistic, in multiple stages and by social class clusters provided by the Social Action Secretary of the City Hall of Lauro de Freitas from the buying power of the neighborhoods residents. Class A was considered (high and high medium), class B (medium), class C (medium and low) and class D (low and poverty).

The town map was initially divided in micro regions according to the predominant social class. 25 streets of the Lauro de Freitas townpart of the four social levels were then drawn (classes A, B, C and D). The street division was proportional to the socioeconomical level and respected the following quantity: six streets in each of the A, B and C clusters and seven streets in class D. In each street, 13 households were drawn by systematic sample. The interval between the houses ranged according to the quantity of households found in each street. In each household visited two adults were drawn (one man andone woman), respecting the proportion of the gender distribution in the population.

The present study was approved by the Ethics Committee of the Adventist Physiotherapy School(FAFIS) situated in the city of Cachoeira, Bahia, Brazil, according to the legal resolution # 0033/2007. All participants signed a Free and Clarified Consent Form and were interviewed at their homes.

Data collection

Data collection occurred from March, 2007 to April, 2008. Five evaluators were prepared accordingly and trained to all the work stages. The inter-evaluator confidence index was tested for application of the IPAQ through the Kappacoefficient, which presented good concordance index (0.61)[15]. The measurements technical error for weight and height was considered low (1.2%)[16].

The demographic data and variables related to health were collected in a questionnaire. Anthropometric data were obtained with the following protocols: height was measured with a Sanny steel anthropometric measuring tape Sanny (Brazil), with the individuals barefoot, at erect position feet and heels united and touching the wall, arms along the body, normal breathing following the Frankfurt plane[17].

Body mass was measured twice using Plenna scales with precision of 100 grams, all previously checked by the National Metrology Institute (Inmetro). The individual was asked to step on the scale barefoot, wearing the least clothes as possible[17].

Physical activity was measured with the IPAQ (International Physical Activity Questionnaire) long version, composed of questions about frequency and duration of physical activities performed in the four domains (work, commuting, household and leisure time)[18].

Energetic expenditure was calculated by multiplying the value of energy expenditure according to the activity performed, considering the weekly frequency and its duration (mean time in minutes/week).

The data obtained in the IPAQ were converted in METs with the proposal by Heymsfield[19], considering the following values for each domain:

- Work – walking = 3.3 METs; moderate activities = 4.0 METs; vigorous activities = 8.0 METs;
- Commuting – walking = 3.3 METs, bicycle = 6.0 METs;
- Household – moderate (gardening or outdoor care) = 4.0 METs, moderate (inside the house) = 3.0 METs, vigorous (gardening or outdoor care) = 5.5 METs;
- Leisure time – walking = 3.3 METs, moderate = 4.0 METs, vigorous = 8.0 METs.

The caloric expenditure in MET minute/week was found by multiplying the MET value of the activity performed by the weekly frequency and its duration.The value obtained was multiplied by the weight and divided by 60 minutes to be changed to kilocalories (kcal). Thus, the caloric expenditure value was found in the activity in METs and also in kcal during the week[19].

The presence or absence of diabetes was self-reported considering the previous medical report according to the question used by the VIGITEL system (Ministry of Health, 2007)[20]: "Has any doctor ever told you that you have diabetes?" In case the individual did not know, the prescribed medication was checked for the presence of oral anti-diabetic drugs among them.

STATISTICAL ANALYSIS

The predictive power and the cutoff points of the different physical activity domains for absence of diabetes were identified by Receiver Operating CharacteristicCurves (ROC), frequently used for determination of cutoff points in diagnostic or triage tests[21].

The total area under the ROC curve between the total physical activity, its different domains (work, commuting, household and leisure) and absence of diabetes was initially identified. The bigger the area under the ROC curve, the greater the discriminatory power of the different domains of physical activity for absence of diabetes. Confidence interval (CI) was at 95%. The CI calculation at 95% determines if the predictive capacity of the caloric expenditure is not occasional, and its lower threshold should not be lower than 0.50[22].

In the sequel cutoff points in kcal/week of the predicting variables of absence of diabetes, with their respective sensitivity and specificity were found.The cutoff points were identified according to the most suitable balance between sensitivity and specificity of the physical activity variables as discriminators of absence of diabetes. Student's ttest for continuous variables and the Chi-square test "x^2" for category variables with significance for $p< 0.05$ were applied to identify the sample's homogeneity between genders. Data were analyzed in the STATA statistical program, version 7.0.

RESULTS

The sample was composed of 522 individuals, 220 male and 302 female. Its characteristics are presented in table1. It is observed that the men are heavier and taller than the women. Concerning age, no differences were found between genders.

Concerning the physical activity domains, the men are more active at work, in commuting and leisure time, while the women are more active in the household activities. In the total physical there are not differences between men and women in the energetic expenditure during the week. It is also observed that there are not differences between genders concerning presence or absence of diabetes.

In table 2 we can observe the areas under the ROC curves, with their respective confidence intervals, of the different physical activity domains as predictors of absence of diabetes. ROC curves were designed analyzing men and women together, for the male gender alone and for the female gender alone.Bigger areas under the curves are observed when men and women are analyzed together (leisure time activity and total physical activity) or when the men are assessed separately, in the commuting, leisure time and total physical activity domains (figures 1 and 2). In the female gender assessment, none of the domains presented areas under the ROC curve with significance to be considered predictors of absence of diabetes.

Table 1. Mean, standard deviation, minimum, maximum and percentage values of the variables assessed in the study.

	Men (n = 220)	Women (n = 302)	p-value
Age (years)	40.2 ± 15.3 (18-85)	40.4 ±14.7 (20-86)	0.88
Weight (kg)	75 ± 14.07 (41-126)	68 ± 14.40 (43.3-129)	0.00
Height (M)	1.70 ± 0.081 (1.41-1.92)	1.58 ± 0.073 (1.36-1.82)	0.00
Physical activity work (kcal/week)	1.961.3 ± 4.424.3 (0-34-330.8)	699.6 ±2.483.2 (0-25-909.3)	0.00
Physical activity in commuting (kcal/week)	789.4 ± 1.267.9 (0-7-691.9)	557.7 ±1.201.0 (0-13-749.1)	0.03
Physical activity household (kcal/week)	1.279,8 ± 2.989,9 (0-29-635,2)	2.552.8 ± 3.263.0 (0-25-277.9)	0.00
Physical activity in leisure time (kcal/week)	737.9 ± 1.261.7 (0-7-900.8)	389.0 ± 913.8 (0-6-700.0)	0.00
Total physical activity (kcal/week)	4.782.5 ± 5.669.2 (0-36-071.3)	4.199.2 ± 4.707.5 (0-35-334.1)	0.20
Diabetes (%) Presence Absence	4.55 95.45	3.31 96.69	0.31

Continuous values were compared by Student's t test for independent samples and percentage values through the Chi-square test.

Table 2. Areas under the ROC curve and CI 95% between the caloric expenditure of the total physical activity and of its different domains as predictors of absence of diabetes in adults.

Domínios da atividade física	Area	CI (95%)	P
Both genders			
Work	0.58	0.48-0.67	
Commuting	0.58	0.47-0.70	
Household	0.57	0.45-0.69	
Leisure time	0.60	0.50-0.69*	
Total	0.66	0.53-0.78*	0.19†
Male			
Work	0.60	0.43-0.77	
Commuting	0.62	0.50-0.75*	
Household	0.55	0.40-0.70	
Leisure time	0.68	0.57-0.79*	
Total	0.69	0.51-0.86*	0.15†
Female			
Work	0.58	0.47-0.68	
Commuting	0.55	0.32-0.75	
Household	0.55	0.38-0.71	
Leisure time	0.53	0.38-0.69	
Total	0.62	0.44-0.79	0.05†

ROC = receiver operating characteristic; CI95% = confidence interval at 95%.
*Area under the ROC curve presenting discriminatory power for absence of diabetes (Li-CI ≥ 0.50).
† Chi-square test.

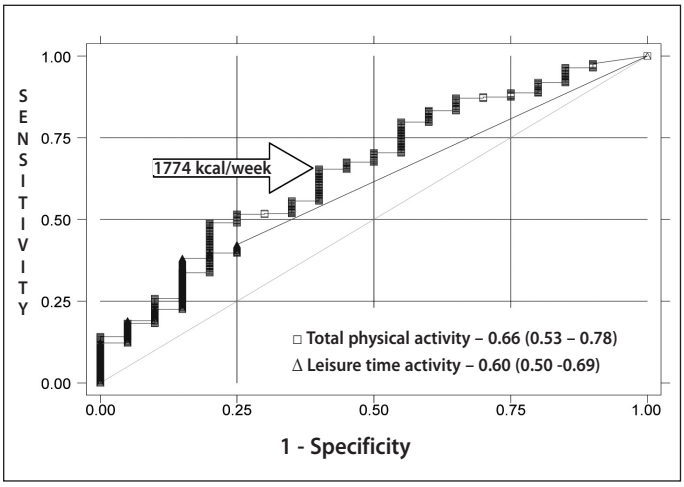

Figure 1. Areas under the ROC curve comparing the caloric expenditure of the total physical activity with its respective cutoff point and the physical activity in leisure time as predictors of absence of diabetes in men and women analyzed together.

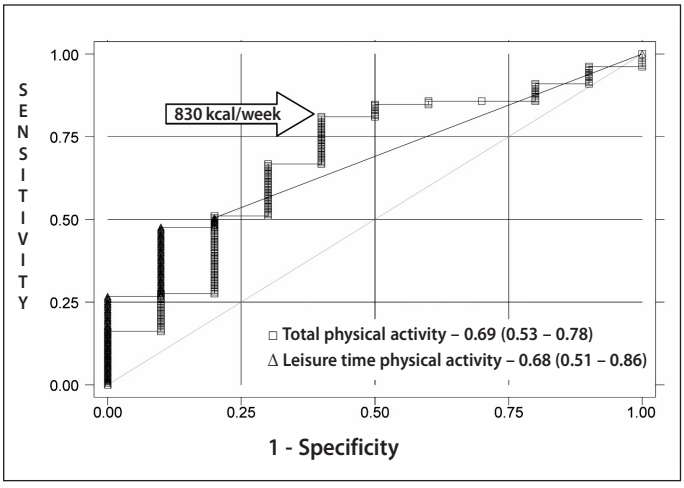

Figure 2. Areas under the ROC curve comparing the caloric expenditure of the total physical activity with its respective cutoff point and the leisure time physical activity as predictors of absence of diabetes in male individuals.

The cutoff points were generated considering the significance of the areas under the ROC curves and the sensitivity and specificity values found. Thus, it was only possible to determine the cutoff points of weekly caloric expenditure (kcal/week) to predict the absence of diabetes for total physical activity: considering both genders together (cutoff point = 1,774kcal/week; sensitivity = 64.9%; and specificity = 60%) and for the male gender (cutoff point = 830kcal/week; sensitivity = 80.9% and specificity = 60%).

DISCUSSION

The present study demonstrates the predictive power of the total physical activity and of its different domains (work, commuting, household and leisure time) for the absence of diabetes. Additionally, it identifies the cutoff points of physical activity in kilocalories spent per week, considering the total physical activities (sum of the weekly caloric expenditure in the four domains) in both sexes and separately for the male sex to discriminate the absence of diabetes.

A possible limitation to this study was the determination of diabetes by self-reported method, which could have caused underestimation in the prevalence of this variable, considering that many individuals can ignore their diabetic condition. Moreover, the fact there was not stratification of the age groups may have been another limitation, considering that for different age groups the weekly caloric expenditure need for protection against diabetes may vary. Another limitation may be the difficult data collection in the classes C and D neighborhoods due to violence reasons, which generated lower percentage of individuals in the sample of these socioeconomical levels. Furthermore, the determination of the energetic expenditure by indirect method, despite being widely used in epidemiological studies, can constitute in another limitation of the present study.

Some research has shown that physical activity may provide benefits in the prevention and treatment of diabetes[23,24]; however, few investigations have tried to identify the predictive power of physical activity, especially when assessing its many domains expressed in weekly caloric expenditure as discriminator of absence of diabetes.

In a recent article[25] the association between physical activity in leisure time, at work and diabetes among 1,651 Native Americans was assessed.The results showed that those who participated in any level of physical activity presented lower risk of diabetes when compared with those who did not practice physical activities.

In the present study it was observed that only the leisure time, commuting and total physical activities (considering the four domains) were predicting of absence of diabetes.The household and work activities were not isolate discriminators for absence of diabetes. Concerning commuting and according to our results, in a study in 11,073 Japanese men[26] it was observed that walk to work with duration longer than 21 minutes per day reduced the risk for diabetes.

In another article[27], where 3,316 Finnish of both genders, type 2 diabetes patients were followed, it was observedthat moderate or vigorous physical activity reduced cardiovascular mortality in diabetic patients.It was also observed that not only physical activity in leisure time, but physical activities at work and during commuting are important components of the active lifestyle in diabetic individuals.

Still in Finland[28], 6,898 men and 7,392 women were followed for 12 years with the aim to identify which of the physical activity domains would provide reduction in the risk of diabetes. As a result, it was observed that moderate or vigorous physical activity at work, during commuting or in leisure time significantly reduced risk of diabetes in the population.

It is important to highlight that this study evidenced that the weekly caloric expenditure as a result of total physical activity (considering the four domains together) is a predictor of absence of diabetes, suggesting hence that the sum of the physical activities performed at work, in commuting, in household and in leisure time are important for the prevention of diabetes. It is also important to stress that areas under the ROC curve ranging from 0.55 to 0.69 for habitual physical activity discriminating diabetes are extremely high. It should be considered that physical activity alone was able to discriminate diabetes, despite its multifactorial character.

In the present investigation, the weekly caloric expenditure cutoff points of the total physical activity were identified for the absence of diabetes. Considering both sexes (men and women), the cutoff point of the total physical activity was 774kcal/week, and, considering men only, the cutoff point for caloric expenditure was approximately half (830kcal/week). The lowest cut off point found in men assessed independently is probably due to the lower prevalence of sedentarism among them, as well as to the fact the number of men has been lower than women's. In addition to that, it is possible that men need less caloric expenditure to prevent metabolic and cardiovascular episodes. In the literature reviewed, studies which identified cut off points of physical activity in weekly caloric expenditure as predictors of absence of diabetes have not been found. Thus, it was chosen to present some results of studies which identified energetic expenditure for physical activities for protection against coronary arterial disease and mortality by any cause.

In an investigation which[29] followed 7,337 men with mean age of 66 years; it was observed that those who reported perceived exertion as relatively strong were the ones who obtained higher protection against coronary arterial disease, regardless of their caloric expenditure being higher or lower than 1,000kcal/week.

A review study[30], from 36 articles by many authors suggested that the cutoff point of 1,000kcal/week in physical activity could reduce mortality by all causes in women and that these values could be also used for men.

The results found in this study suggest that physical activity in leisure time, in commuting and total (sum of the activities in the four domains) are predicting for absence of diabetes. Concerning the necessary amount of physical activity (considering the four domains), a caloric expenditure of 830kcal/week for men and 1,774kcal/week for men and women analyzed together would be necessary for the protection.

New studies with different populations which examine the intensity and duration of the physical activity in minutes per week, as well as the necessary caloric expenditure for protection against diabetes and other metabolic and cardiovascular aggravation are suggested.

All authors have declared there is not any potential conflict of interests concerning this article.

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