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Relationship between obstructive sleep apnea syndrome and functional capacity in patients with diabetes mellitus type 2: an observational transversal study

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SUMMARY

OBJECTIVE: The aim of this study was to verify the association among obstructive sleep apnea, functional capacity, and metabolic control.

METHODS: This was a cross-sectional study involving individuals of both sexes with clinical diagnosis of diabetes mellitus type 2 who were above 18 years of age. The assessment consisted of a volunteer identification form, a 2-minute step test, and the Stop-Bang questionnaire. In order to assess metabolic control, HbA1c and fasting glucose data were collected from medical records.

RESULTS: A total of 100 individuals with diabetes mellitus type 2, of whom 61% were women, were included in this study. According to the Stop-Bang instrument, 26, 57, and 17% of patients had low, intermediate, and high risk of developing OSA, respectively. There was no association between the 2-minute step test and metabolic variables and diabetes mellitus type 2 chronicity with Stop-Bang.

CONCLUSIONS: We concluded that there is no association among obstructive sleep apnea measured by means of Stop-Bang instrument, functional capacity measured by means of 2-minute step test, and metabolic variables in individuals with diabetes mellitus type 2.

KEYWORDS: Sleep apnea. Diabetes mellitus. Exercise test. Metabolic disease.

INTRODUCTION

Obstructive sleep apnea (OSA) syndrome is a chronic disorder of multifactorial etiology that affects about 2–4% of the adult population, and it is characterized by partial or total airway occlusion during sleep, related to anatomical changes of the respiratory tract, neuromuscular factors, and genetic predisposition, with consequent reduction or cessation of airflow, thus causing respiratory arrest for 10 s or more[1-2].

Among the associated pathologies, diabetes mellitus (DM) often presents itself as a disorder that coexists with OSA, and this coexistence is justified with the risk factors shared with other disorders, such as obesity. In addition, studies indicate that short sleep duration is associated with decreased glucose tolerance, insulin sensitivity, and a consequently increased risk of developing diabetes[3-6]. Furthermore, research suggests that diabetic patients are more likely to sleep during the day than

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nondiabetic patients and are more likely to be involved in traffic accidents due to daytime sleepiness[7].

Polysomnography, although considered the gold standard for diagnosing this syndrome, is of high cost and is difficult to access. In this sense, low-cost instruments, easy applicability, and availability have been used, as is the case with questionnaires. Thus, the Stop-Bang questionnaire demonstrated good sensitivity and specificity in screening for this syndrome[2,8].

Functional capacity may be negatively affected in individuals with OSA associated with fatigue, excessive sleepiness, excess weight, and low energy, which characterize the clinical presentation of the pathology[9]. Therefore, the 2-minute step test (2MST) appears as an alternative way to assess the functional capacity of an individual, considering that the ability to walk reflects the ability to maintain a series of activities of daily living in addition to enabling knowledge of the functional profile and the ability to guide decision-making in strategies aimed at preventing disabilities[10,11].

Given the above, the hypothesis of this study was that there is an association among OSA, functional capacity, and metabolic variables in individuals with DM. Therefore, the objective of this study was to verify the association among OSA, functional capacity, and metabolic control variables.

METHODS

This was a cross-sectional, observational, and analytical study developed at the Ceuma University (Street Josué Montello, 1, Jardim Renascença, CEP 65075-120, São Luís, MA, Brazil), with a recruitment period from August 2018 to August 2019 after the study procedures were approved by the Research Ethics Committee of the said institution by means of opinion number 2.469.206. All volunteers included in this study validated their participation by signing the informed consent form.

The inclusion criteria adopted were as follows: individuals of both sexes, with a clinical diagnosis of diabetes mellitus type 2 (T2DM) according to the Brazilian Diabetes Society, and aged ≥18 years. All volunteers were sedentary according to self-report. The exclusion criteria in the present study were as follows: patients with uncontrolled systemic arterial hypertension, amputated diabetes and unable to perform the 2MST, cardiovascular and respiratory diseases limiting their ability to participate in the proposed tests, a clinical diagnosis of neurological diseases, the inability to understand the tests and questionnaires, and any type of medication to sleep.

The assessment consisted of a volunteer identification form, the 2MST, and the Stop-Bang questionnaire[8]. In order to assess metabolic control, HbA1c and fasting glucose data were collected from medical records.

The 2MST is calculated by measuring the number of elevations using a knee as a reference. For this study, the number of right knee elevations for 2 min without running was counted and standardized. The minimum knee height, appropriate for the stride, was leveled at a midpoint between the patella and the anterosuperior iliac spine[11].

During the test, the patient was accompanied by a team member and received support if there was a chance of imbalance. The vital signs were monitored before the start and at the end of the test. The blood pressure (BP) measurement was evaluated using a sphygmomanometer and stethoscope (Premium brand), and the peripheral oxygen saturation (SpO_2) and heart rate were measured using an oximeter (MeasuPro model OX150, USA) with a sensor positioned on the index finger and the reading determined after signal stabilization. The chronometer was triggered and interrupted only if the patient requested suspension of test; if indicated by chest pain, intolerable dyspnea, excessive sweating, pallor, dizziness, or cramps; if his/her BP needed to be checked; or if the stipulated time was over. If the patient suddenly interrupted the walk simply to take rest, the timer continued to run. Patients were instructed to wear comfortable clothes and shoes at the time of the test and to take their medications normally.

The Stop-Bang questionnaire consists of a series of eight questions related to snoring, tiredness/fatigue/drowsiness, interrupted breathing during sleep, BP, body mass index, age, neck circumference, and gender, with a total score ranging from 0–8 and answers of only yes or no (scores 1 and 0, respectively). The presence of three or more affirmative responses indicates a high risk for OSA[8].

Statistical analysis

Descriptive analysis was performed and presented with the minimum, maximum, average, and standard deviation values. In addition, to verify the association between the risk of developing OSA with the other variables evaluated, logistic regression was used with the following independent variables: 2MST, HbA1c, blood glucose, and chronicity of T2DM. The association values were presented through the odds ratio (OR) and 95% confidence interval (CI). The risk of developing OSA, assessed using the Stop-Bang questionnaire, was categorized as follows: patients with intermediate and high risk were grouped in the high risk group (n=74) and patients with low risk were grouped in the low risk group (n=26). All data were analyzed using SPSS software (version 17.0; Chicago, IL, USA) at a significance level of 5%.

RESULTS

A total of 160 patients with T2DM were initially recruited at a secondary health care center for patients with T2DM. However, after applying the eligibility criteria, 60 patients were excluded,

leaving a final sample containing 100 individuals with T2DM, of whom 61% were women.

According to the Stop-Bang instrument, 26, 57, and 17% of patients had low, intermediate, and high risk of developing OSA, respectively. Other clinical data of the study participants are described in Table 1.

When verifying the association between the risk of developing OSA and the other variables, it was observed that the logistic regression model that used the Stop-Bang questionnaire presented adequate modeling (overall=72.7%; Hosmer and Lemeshow test, p=0.867; Nagelkerke R^2=0.050). Table 2 presents the OR values, and no significance was identified (p>0.05).

Table 1. Characteristics of the participants with diabetes mellitus type 2.

	Mean	Standard deviation
Age (years)	59.26	9.86
DM2 time (years)	10.07	7.25
Blood glucose (mg/dL)	214.42	100.24
HbA1c (%)	8.31	2.50
Height (m)	1.56	0.08
Weight (kg)	70.38	15.05
BMI (kg/m^2)	28.72	5.41
NC (cm)	37.64	3.73
AC (cm)	97.93	11.87
2MST (score)	68.09	20.21

HbA1c: glycated hemoglobin; BMI: body mass index; NC: neck circumference; AC: abdominal circumference; 2MST: Two-minute step test.

Table 2. Association between the risk of developing obstructive sleep apnea according to the Stop-Bang and the metabolic control and functional capacity of patients with diabetes mellitus type 2.

	β	SE	OR (95%CI)	p-value
Constant	2.632	1.21	–	0.030
2MST	-0.018	0.01	0.98 (0.95–1.00)	0.136
HbA1c (%)	-0.073	0.11	0.93 (0.74–1.15)	0.510
Blood glucose	-0.001	0.01	1.00 (0.99–1.01)	0.629
DM2 chronicity	-0.002	0.03	0.99 (0.93–1.06)	0.924

SE: standard error; OR: odds ratio; CI: confidence interval; HbA1c: glycated hemoglobin; 2MST: two-minute step test.

DISCUSSION

The main findings of this study were as follows:

a) there was no association between OSA and functional capacity measured by means of 2MST and
b) there was no association between OSA and metabolic variables.

Although different methodologies, in agreement with a study by Nisar et al. evaluated on 1,533 individuals, assessed the presence of OSA by polysomnography and the functional capacity by exercise stress echocardiogram, only 404 showed impaired functional capacity. In addition, another recent study highlights the impact of OSA on cardiorespiratory fitness[12].

Recently, a study conducted by Nogueira et al. with the objective of evaluating the reliability of 2MST in healthy individuals concluded that it is a reliable test and still has slight precision in differentiating active and sedentary individuals. The assessment of functional capacity by rapid, simple, and low-cost tests in this population is relevant in view of the need to identify functional limitations due to the disease. In addition, this assessment using this test can and should be used as a method to assess the effectiveness of the proposed treatments[13].

Although OSA was not associated with metabolic variables, it is known that patients affected with this disorder have higher fasting blood glucose levels and high plasma insulin levels, regardless of obesity[14]. In addition, there is an evidence that sleep deprivation is associated with higher glucose levels, development of insulin resistance, and pancreatic beta cell dysfunction, which is justified despite chronic hypoxemia, increased sympathetic nervous system activity, and increased circulating cortisol intermittent observed in individuals with OSA, culminating in a change in the homeostasis of this variable[15-17]. The non-association between OSA and the metabolic variables found in this study may be possibly justified by the discrepancy in the time of diagnosis of DM, as well as by the control and/or lack of metabolic control found in the population in question.

Regarding the possible clinical implications, based on the previous literature and the results of the present study, OSA should be considered as a secondary factor that implies the functional capacity in diabetic patients along with other factors such as diabetic neuropathy and/or cardiovascular autonomic neuropathy. However, longitudinal studies on this topic are needed to support this clinical implication.

This study has some limitations that should be mentioned. There was an important variation in the time since a diagnosis of T2DM; however, it is worth mentioning that although the medical diagnosis was made within this period of time, it is believed that the metabolic disorder existed for a longer time. Furthermore, peripheral neuropathy was not assessed according

to the gold standard[18], but all patients were asked about any difficulty in walking or lack of sensitivity in the metatarsals and feet as a whole.

CONCLUSIONS

We concluded that there is no association among OSA measured by means of Stop-Bang instrument, functional capacity measured by means of 2MST, and metabolic variables in individuals with T2DM.

AUTHORS' CONTRIBUTIONS

MAF: Funding acquisition. **AKSM:** Funding acquisition. **RBSL:** Funding acquisition. **MAO:** Funding acquisition. **ADSA:** Writing-original draft, Writing – review & editing. **ASR:** Supervision. **LRLNP:** Funding acquisition. **PRF:** Conceptualization, Methodology, Formal analysis, Investigation, Writing-original draft. **MCG:** Methodology, Supervision. **DBD:** Conceptualization, Formal Analysis, Methodology, Resources, Funding Acquisition, Investigation, Supervision, Writing-original draft, Writing – review & editing.

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