Behaviors and comorbidities associated with microvascular complications in diabetes

Comportamentos e comorbidades associados às complicações microvasculares do diabetes

Hellen Pollyanna Mantelo Cecilio[1]
Guilherme Oliveira de Arruda[1]
Elen Ferraz Teston[1]
Aliny Lima Santos[1]
Sonia Silva Marcon[1]

Abstract

Objective: To know the prevalence, behavioral factors and comorbidities associated with microvascular complications in diabetes mellitus.

Methods: Cross-sectional study with 318 people with type 2 diabetes *mellitus*, approached by telephone survey. A standardized questionnaire was used for data collection, the comorbidities were added and for the analysis, the Person chi-square test.

Results: More than half of participants (53.8%) reported that microvascular complications were present and the most frequent were ophthalmologic (42.8%), vascular (14.5%) and kidney (12.9%). Among the factors associated with complications, we highlight the inadequate number of meals (49.8%), no physical activity (50.6%), smoking (32.4%), addition of salt to ready to eat foods (86.4%) and hypertension (58.3%).

Conclusion: The prevalence of microvascular complications of diabetes *mellitus* was 53.8%, and behavioral factors as the number of meals per day, physical activity, smoking, addition of salt to ready to eat food and comorbidity, hypertension.

Resumo

Objetivo: Conhecer a prevalência, os fatores comportamentais e comorbidades associadas às complicações microvasculares decorrentes do diabetes *mellitus*.

Métodos: Estudo transversal realizado com 318 pessoas com diabetes *mellitus* tipo 2, abordados por inquérito telefônico. Na coleta de dados foi utilizado questionário padronizado tendo sido acrescentadas as comorbidades e para análise, o Qui-Quadrado de *Pearson*.

Resultados: Mais da metade dos participantes (53,8%) referiu apresentar complicações microvasculares e as mais frequentes foram as oftalmológicas (42,8%), vasculares (14,5%) e renais (12,9%). Dentre os fatores associados às complicações destacam-se o número inadequado de refeições (49,8%), não prática de atividade física (50,6%), uso de cigarro (32,4%), adição de sal na comida pronta (86,4%) e hipertensão (58,3%).

Conclusão: A prevalência de complicações microvasculares decorrentes do diabetes *mellitus* foi de 53,8%, tendo como fatores comportamentais o número de refeições por dia, prática de atividade física, uso de cigarro, adição de sal na comida pronta e comorbidade, a hipertensão arterial.

Corresponding author
Hellen Pollyanna Mantelo Cecilio
Colombo Avenue, 5790, Maringá, PR,
Brazil. Zipe Code: 87020-900
pollymantelo@gmail.com

[1]Universidade Estadual de Maringá, Maringá, PR, Brazil.
Conflict of interest: there are no conflict of interest to be declared.

Introduction

Diabetes *mellitus* is one of the most common chronic noncommunicable disease worldwide, and its prevalence continues to grow due to population aging, economic development and urbanization that led to important changes in the lifestyle, marked by the presence of sedentarism and obesity.[1] This is one of the most important chronic diseases and impactful to the public health system due to the high degree of morbidity and mortality and high costs for metabolic control and treatment of their microvascular complications.[2]

It is estimated that the total number of people with diabetes in the world will rise from 285 million in 2010 to 439 million in 2030, indicating an increase of the disease, especially in developing countries.[3] In Brazil, in this period, this population will increase from 4.5 million, in 2000, to 11.3 million, in 2013, estimating to reach 19.2 million in 2035, becoming the eighth country in the world in number of people with diabetes *mellitus*.[3]

After 15-20 years of living with the disease, despite treatment to prevent the short-term effects, in long term, it can cause many acute and chronic pathological processes, such as dysfunction and kidney failure, eyes, nerves, heart and blood vessels, and it is also one of the major risk factors for cardiovascular disease.[4] The most common microvascular complications are: neuropathy, retinopathy, nephropathy and ischemia,[2,5] which are of microvascular origin and are associated with conditioning factors, which comes from the individual lifestyle, as inadequate eating habits, insufficient physical activity, consumption of alcohol and tobacco, and comorbidities.[2,6]

Considering the importance of the individuals' behavior in the development of type 2 diabetes mellitus, specific interventions in lifestyle can reduce the incidence of the disease and, when already diagnosed, may prevent microvascular complications. With collective actions among health care professionals, individuals and families, it is possible to develop strategies to identify early risk factors, avoid them and/or control them.[7]

Accordingly, identifying the prevalence of microvascular complications caused by diabetes *mellitus* and associated risk factors as well as the groups most at risk for developing them, can subsidy the planning and implementation of health interventions targeting this population.

This study aimed to determine the prevalence, behavioral factors and comorbidities associated with microvascular complications caused by diabetes *mellitus*.

Methods

Cross-sectional study conducted among people with diabetes *mellitus* registered in the Diabetic Association of Maringá, State of Paraná, southern Brazil. This is a nonprofit organization that aims to provide the most affordable diet products and equipment for the control of diabetes *mellitus*. They perform measurement of blood pressure, cholesterol and glucose levels, and quite frequently, they also provide lectures on various topics, delivered by volunteer health professionals.

At that time, 3,730 people were registered in the association, with ages ranging from one to 89 years old; Among these, 1,168 were 18 years or older and diagnosed with diabetes *mellitus* type 2. In order to calculate the sample size, we adopted a prevalence of 50% for complications, the estimate with a confidence interval of 95%, a maximum error of 5% and 10% increase for losses, resulting in a sample of 318 individuals.

The subjects were selected by simple random sampling from the list of active residential telephone numbers, provided by the association, with the names in alphabetical order. Up to three attempts to contact the person were performed at different days and times. When it was not possible to make contact with the selected person, the drawn person was replaced by the next in the list, allowing up to three substitutions before considering loss.

Data were collected through a telephone survey conducted between January and September 2012. In the survey, the adapted questionnaire from the Vigitel research - Monitoring of Risk and Protective factors for Chronic Non Communicable Diseases by Telephone Survey was used,[8] supplemented with issues relating

to sociodemographic characteristics and comorbidities (hypertension and hypercholesterolemia).

The interviews, conducted by health professionals previously trained, had an average duration of 20 minutes and included the presentation of the researcher, the study objectives, methodology (approach by phone) and verbal consent. Responses were recorded on a hard copy of the instrument of data collection. Interviewers clarified the doubts of the participants regarding the research when necessary and, every time they were requested, they would also clarify aspects related to the control of diabetes *mellitus* after the interview.

Behavioral variables and comorbidities were addressed: food consumption (adequate and inadequate), regular physical activity (yes/no), smoking (yes/no), alcohol consumption (yes/no), presence/absence of comorbidities (hypertension and hypercholesterolemia). Dietary patterns were classified as adequate when patients reported eating fruits and vegetables five or more times a week; always removed the skin and visible fat from meat; consumed less than one serving of sweets, cake, cookie or soda per day; did not consume whole milk; and did not add salt to ready to eat food. The number of meals was considered adequate when they had five or more meals per day.

The collected data were categorized and entered on Microsoft Office Excel® 2010 software and analyzed using the Statistical Package for the Social Sciences®. We used nonparametric Pearson chi-square test to identify significant differences in the proportions of the microvascular complications of diabetes mellitus, according to behavioral variables and comorbidities. The measure of association used was the odds ratio with 95% confidence interval of and significance level set at p<0.05.

The development of the study met national and international standards of ethics in research involving human beings.

Results

A total of 318 people with diabetes mellitus were interviewed, and more than half were female (54.1%) aged between 22 and 89 years old, with a mean of 63.1 years and a higher prevalence in the age group between 60 and 79 years (57.9%). Most participants reported having a partner (73.6%) and more than half had completed elementary school (52.8%). Regarding health behavior, 75.2% reported no physical activity, 70.8% did not make the appropriate number of meals daily, alcohol consumption corresponded to 23.6%, 11.9% had an inadequate dietary pattern, 10.7% made use of tobacco and 6.9% added salt to ready to eat food.

With regard to the prevalence of comorbid conditions studied, it was found that 66.4% and 37.7% reported, respectively, presence of hypertension and hypercholesterolemia. Microvascular complications were reported by 171 subjects (53.8%) and the most frequent one were ophthalmic (42.8%), followed by vascular (14.5%) and kidney (12.9%). It was found that the appropriate number of daily meals, the addition of salt to ready to eat food, physical activity, not smoking and self-reported hypertension were associated with microvascular complications in general, as table 1.

Table 1. Univariate analysis of the microvascular complications of diabetes *mellitus*, according to behavioral variables and health condition

Behavioral variables and health condition	Complications of diabetes *mellitus*		p-value	OR (95% CI)
	Yes n(%)	No n(%)		
Number of meals per day				
Adequate	59(63.4)	34(36.6)	0.026	0.57 (0.34-0.93)
Inadequate	112(49.8)	113(50.2)		
Dietary pattern				
Adequate	155(55.4)	125(44.6)	0.124	0.58 (0.29-1.16)
Inadequate	16(42.1)	22(57.9)		
Salt addition				
Yes	19(86.4)	3(13.6)	0.001	6.0 (1.73-20.7)
No	152(51.4)	144(48.6)		
Physical activity				
Yes	50(63.3)	29(36.7)	0.050	0.59 (0.35-1.00)
No	121(50.6)	118(49.4)		
Alcohol consumption				
Yes	37(49.3)	38(50.7)	0.387	0.79 (0.47-1.33)
No	131(55.0)	107(45.0)		
Smoking habits				
Yes	11(32.4)	23(67.6)	0.008	0.37 (0.17-0.78)
No	160(56.3)	124(43.7)		
Hypertension				
Yes	123(58.3)	88(41.7)	0.023	1.71 (1.07-2.74)
No	48(44.9)	59(55.1)		
Hypercholesterolemia				
Yes	73(60.8)	47(39.2)	0.055	1.56 (0.98-2.48)
No	98(49.7)	99(50.3)		

OR – Odds Ratio; 95%CI– 95% Confidence Interval

Table 2. Univariate analysis of microvascular complications according to behavioral variables and health condition

Behavioral variables and health conditions	Ophthalmic complications (n=136)			Renal complications (n= 41)			Neuropathic complications (n=46)		
	n(%)	p-value	OR (95%CI)	n(%)	p-value	OR (95%CI)	n(%)	p-value	OR (95%CI)
Number of meals per day									
Adequate	51(54.8)	0.005	0.50(0.30-0.81)	13(14.0)	0.710	0.87 (0.43-0.77)	14(15.1)	0.848	0.93(0.47-1.84)
Inadequate	85(37.8)			28(12.4)			32(14.2)		
Dietary pattern									
Adequate	125(44.6)	0.066	0.50(0.24-1.05)	37(13.2)	0.643	0.77 (0.26-2.30)	40(14.3)		1.12(0.44-2.86)
Inadequate	11(28.9)			4(10.5)			6(15.8)	0.805	
Salt addition									
Yes	15(68.2)	0.013	3.09(1.22-7.82)	3(12.9)	0.914	1.07 (0.30-3.79)	5(22.7)	0.254	1.82(0.64-5.22)
No	121(40.9)			38(12.8)			41(13.9)		
Physical activity									
Yes	44(55.7)	0.007	0.49(0.29-0.83)	7(8.9)		1.70 (0.72-4.01)	8(10.1)		1.67(0.74-3.76)
No	92(38.5)			34(14.2)	0.217		38(15.9)	0.206	
Alcohol consumption									
Yes	28(37.3)	0.272	0.74(0.43-1.26)	8(10.7)		0.77 (0.33-1.75)	10(12.0)		0.76(0.35-1.67)
No	106(44.5)			32(13.4)	0.530		36(15.1)	0.501	
Smoking habits									
Yes	7(20.6)	0.006	0.31(0.13-0.73)	3(8.8)		0.62 (0.18-2.15)	5(14.7)	0.966	1.02(0.37-2.79)
No	129(45.4)			38(13.4)	0.454		41(14.4)		
Hypertension									
Yes	101(47.9)	0.010	1.88(1.16-3.07)	32(15.2)	0.089	1.94 (0.89-4.24)	31(14.7)	0.872	1.05(0.54-2.05)
No	35(32.7)			9(8.4)			15(14.0)		
Hypercholesterolemia									
Yes	58(48.3)	0.127	1.42(0.90-2.25)	16(13.3)	0.869	1.05 (0.54-2.07)	20(16.7)	0.395	1.31(0.69-2.47)
No	78(39.6)			25(12.7)			26(13.2)		

OR – *Odds Ratio*; 95% CI– 95% Confidence Interval

Behavioral variables and health conditions which presented association with microvascular complications, in general, also presented statistical relationship with the ophthalmic complication, but were not associated with renal and neuropathic complication, as shown in table 2.

Discussion

Limitations of this study relate to the use of the telephone survey as data collection strategy from individuals registered to an association, making it impossible to generalize the results to other settings, especially for being based on self-reported data. However, several studies indicate that the accuracy of self-reported morbidity information varies according to the type of disease, its severity, the presence of comorbidities and socioeconomic characteristics. A study conducted in southeast Spain showed, for example, that self-reported diagnosis of diabetes had higher validity when compared to the report of hypertension and dyslipidaemia.[9]

The use of telephone survey is an efficient strategy of communication with users, as it potentializes ease, low cost and speed.[10] In Brazil, this feature has been used successfully in populations in which the telephone services reach the majority of residences.

Regarding the profile of respondents, the highest prevalence of women in line with the result of a study conducted in Canada, which showed higher prevalence of diabetes for women immigrants from Latin America and the Caribbean,[11] which was also identified in a study with Spanish population.[12] In this sense, a review study on the epidemiology, management and cost of complications associated with type 2 diabetes in Brazil, found increased demand for health services and assistance from women, due to greater concern with health issues they have.[2] Furthermore, prevalence can be explained by the way the sample was planned, as the calls to apply for participation in the study were performed for residences in business hours.

The highest prevalence of people in the age group of 60-79 years may be due to the fact these people are the ones that stay at home, but may

also be related to the increase in disease incidence with increasing age, which also was verified in other studies.[2,11,12] The large proportion of people with a partner and the fact that more than half of them had completed elementary school constitute protective factors for the development of microvascular complications such as mortality from diabetes *mellitus* has been more frequent among widowers and singles,[2] while the higher risk of developing complications of the disease[2,11] has been found in people with low education, given the greater difficulty in the teaching and learning process and, consequently, lower adherence to treatment.

Nevertheless, it is essential to consider the behavior and habits of each individual, because, commonly, acute and chronic complications arising from diabetes *mellitus* are associated with lifestyle, that is, to the way the individual controls glucose levels.[2] Indeed, among the main factors and habits that can help control the disease are proper nutrition and weight control, which may provide improvement in glycemic control, with consequent reduction of risk for cardiovascular disease and improvement in quality of life.[13]

In the present study, it was found that individuals who experienced a complication of diabetes mellitus reported more frequently, adequate number of meals, although they added salt to ready to eat food, which explains, in part, hypertension being the most frequent comorbidity. Moreover, these individuals reported more concern about physical activity and not smoking. Proper handling of food is essential for the prevention of microvascular complications, it is important not only to have the appropriate number of meals, but also to observe the characteristics of the food consumed, since they can act either as protectors or promoters of complications.[13-15]

Changes in lifestyle are also very important to control the disease, especially considering the consumption of foods with low glycemic levels, and rich in fiber such as whole grains, legumes, vegetables and fruits, favoring glucose and insulin metabolism.[15,16] The appropriate number of daily meals and their quality contributes to weight control and glucose levels which can aid in the reduction of cardiovascular risk factors, prevent acute and chronic complications, and promote overall health to patient.[2] It is noteworthy that people with diabetes mellitus are usually more careful in the choice of foods, avoiding those that contribute to weight gain, such as pizza, lasagna and pasta.[14]

Additionally proper diet, exercise has been considered one of the three main factors for the control of diabetes *mellitus*,[17] since its regular practice improves circulation, lowers blood glucose, enhances the action of insulin, collaborates in weight control, hypertension and lowering cholesterol and triglycerides.[2]

Regarding physical activity, most people interviewed said they did not practice it as recommended. Another study also found that the frequency in people with diabetes mellitus who regularly engage in physical activity is low.[16]

Although no statistically significant association was observed between alcohol consumption and microvascular complications of diabetes *mellitus*, diverging of the findings of a retrospective study that showed association between these variables,[18] it is known that excessive alcohol consumption in the long term increases the incidence of complications of disease while the reduced consumption is considered a protective factor.[19] The frequency of individuals who do not smoke and who had microvascular complications was significantly higher when compared to individuals who smoked. This finding differs from results found in another study in which smokers were nearly 11 times more likely to microvascular complications.[18] Thus, it is believed that at least part of nonsmokers who had complications are actually former smokers.

However, we highlight the identification of deleterious behaviors associated only with ocular complications. While smoking causes harmful effects to the retina[20] in this study, we showed an inverse association between smoking habits and ophthalmic complications, as the frequency of individuals with this type of complication was higher among nonsmokers. This allows inferring that these individuals were smokers and suspended the use of cigarettes,

after the emergence of complications, in order to prevent its aggravation.

Nevertheless, it is observed that there is no consensus in the literature regarding the association between cigarette smoking and ophthalmic complications, which may be related to the fact that smokers, because they have lower life expectancy, do not reach advanced ages when the risk of developing ophthalmic complications increases substantially.[20]

Hypertension, although not an exclusively behavioral factor in nature, implies considerably in the emergence of microvascular complications among individuals with diabetes *mellitus*, particularly when coupled with long time of diagnosis and lack of glycemic control. The results of this study show that individuals with high blood pressure more frequently reported microvascular complications, especially in relation to ophthalmic complications. Hypertension is a major risk for developing ophthalmic complications in the form of hypertensive retinopathy, considerably increasing the occurrence of this condition among people with diabetes mellitus, especially when the disease is not adequately controlled.[21]

Deficiency in the control of cholesterol levels can also predispose microvascular complications in individuals with diabetes *mellitus*, but there was no significant difference in the frequency of microvascular complications in those with and without hypercholesterolemia, even in the case of renal complications where the rate was almost double among those who reported hypercholesterolemia.

Conclusion

The prevalence of microvascular complications of diabetes *mellitus* was 53.8%, considering the following behavioral factors: number of meals per day, physical activity, smoking habits, addition of salt to ready to eat food and the comorbidity hypertension.

References

1. Whiting DR, Guariguata L, Weil C, Shaw J. IDF Diabetes Atlas: Global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes Res Clin Pract. 2011; 94(3):311-21.

2. Bertoldi AD, Kanavos P, França GV, Carraro A, Tejada CA, Hallal PC, et al. Epidemiology, management, complications and costs associated with type 2 diabetes in Brazil: a comprehensive literature review. Globalization Health. 2013; 9:62.

3. Zhang P, Zhang X, Brown J, Vistisen D, Sicree R, Shaw J. Global healthcare expenditure on diabetes for 2010 and 2030. Diabetes Res Clin Pract. 2010; 87(3):293-301.

4. Ozougwu JC, Soniran OT. Diabetes mellitus. A review. Pharmacologyonline. 2011; 2:531-43.

5. Shaw JE, Sicree RA, Zimmet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. Diabetes Res Clin Pract. 2010; 87(1):4-14.

6. Yadav R, Tiwari P, Dhanaraj E. Risk Factors and complications of type 2 diabetes in Asians. CRIPS. 2008; 9(2):8-12.

7. Lakerveld J, Bot SD, Chinapaw MJ, Maurits van Tulder W, Kostense PJ, Dekker JM, et al. Motivational interviewing and problem solving treatment to reduce type 2 diabetes and cardiovascular disease risk in real life: a randomized controled trial. Int J Act Behav Nutr Phys. 2013;10:47.

8. Iser BP, Malta DC, Duncan BB, de Moura L, Vigo A, Schmidt MI. Prevalence, correlates, and description of self-reported diabetes in brazilian capitals – results from a telephone survey. Plos One. 2014; 9(9): e108044.

9. Huerta JM, Tormo MJ, Egea-Caparrós JM, Ortolá-Devessa JB, Navarro C. Accuracy of self-reported diabetes, hypertension, and hyperlipidemia in the adult Spanish population. DINO study findings. Rev Esp Cardiol. 2009; 62(2):143-52.

10. Hu SS, Balluz L, Battaglia MP, Frankel MR. improving public health surveillance using a dual-frame survey of landline and cell phone numbers. Am J Epidemiol. 2011; 173(6):703-11.

11. Creatore MI, Moineddin R, Booth G, Manueal DH, DesMeules M, McDermott S, Glazier RH. Age and sex-related prevalence of diabetes *mellitus* among immigrants to Ontario, Canada. CMAJ. 2010; 182(8):781-9.

12. Soriguer F, Goday A, Bosch-Comas A, Bordiú E, Calle-Pascual A, Carmena R, et al. prevalence of diabetes *mellitus* and impaired glucose regulation in Spain: the Di@bet.es Study. Diabetologia. 2012; 55(1):88-93.

13. Look AHEAD Research Group, Wing RR, Bolin P, Brancati FL, Bray GA, Clark JM, et al. Cardiovascular effects of intensive lifestyle intervention in type 2 diabetes. N Engl J Med. 2013; 369(2):145-54.

14. Seligman HK, Jacobs EA, López A, Tschann J, Fernandez A. food insecurity and glycemic control among low-income patients with type 2 diabetes. Diabetes Care. 2012; 35(2):233-8.

15. Wing RR, Bolin P, Brancati FL, Bray GA, Coday M, Ceow RS, et al. Cardiovascular Effects of Intensive Lifestyle Intervention in Type 2 Diabetes. N Engl J Med. 2013; 369(2):145-54.

16. Donahue KE, Mielenz TJ, Sloane PD, Callahan LF, Devellis RF. Identifying supports and barriers to physical activity in patients at risk for diabetes. Prev Chronic Dis. 2006; 3(4): A119.

17. Yang W, Lu J, Weng J, Jia W, Ji L, Xiao J, et al. Prevalence of diabetes among men and women in China. N Engl J Med 2010; 362(12):1090-101.

18. Umamahesh K, Vigneswari A, Surya Thejaswi G, Satyavani K, Viswanathan V. Incidence of cardiovascular diseases and associated risk factors among subjects with type 2 diabetes - an 11-year follow up study. Indian Heart J. 2014: 66(1):5-10.

19. Beulens JW, Kruidhof JS, Grobbee DE, Chaturvedi N, Fuller JH, Soedamah-Muthu SS. Alcohol consumption and risk of microvascular complications in type 1 diabetes patients: the EURODIAB Prospective Complications Study. Diabetologia. 2008; 51(9):1631-8.

20. Esteves J, Rosa CM, Kramer CK, Osowski LE, Milano S, Canani LH. Absence of diabetic retinopathy in a patient who has had diabetes *mellitus* for 69 years, and inadequate glycemic control: case presentation. Diabetol Metab Syndr. 2009; 1(1):13.

21. Mohamed IN, Soliman SA, Alhusban A, Matragoon S, Pillai BA, Elmarkaby AA, et al. Diabetes exacerbates retinal oxidative stress, inflammation, and microvascular degeneration in spontaneously hypertensive rats. Mol Vis. 2012; 18:1457-66.