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# Nutritional assessment of older adults with diabetes mellitus

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## ABSTRACT

**Aims:** We aimed to screen the nutritional status of older adults with diabetes mellitus, seeking to outline the needs of this population group considering their socioeconomic status.

**Methods:** Cross-sectional study of 246 diabetic people aged 65–94 years in Northeastern Brazil. Semi-structured questionnaires were used to collect sociodemographic, general health and lifestyle data. The Mini Nutritional Assessment was used to screen nutritional status. **Results:** Participants' mean age was  $73 \pm 6.4$  years, and there was a predominance of women (56.5%). The mean duration of diabetes was 14.1 years ( $\pm 9.6$  years). Patients aged 80 years or older presented a 3.7-fold higher risk of malnutrition ( $p < 0.001$ ), and those who were uneducated exhibited a 5.8-fold higher risk of malnutrition ( $p = 0.040$ ). Patients with BMI of  $18.6\text{--}24.9 \text{ kg/m}^2$  presented a 2.2-fold higher risk of malnutrition than overweight or obese patients ( $p < 0.001$ ). Nutritional status was significantly associated with coronary artery disease ( $p = 0.010$ ) and stroke ( $p < 0.001$ ). Malnourished patients exhibited a 2.2-fold higher occurrence of infection in the past 6 months ( $p = 0.017$ ) and 2-fold higher occurrence of foot injuries ( $p = 0.028$ ) than their well-nourished peers.

**Conclusion:** Malnutrition in older diabetic patients exacerbates underlying diseases and contributes to unfavorable prognosis, particularly in the oldest old and in individuals with low levels of education.

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## 1. Introduction

Noncommunicable diseases (NCDs) are now the main cause of mortality in adults aged 60 and over [1]. The four main types of NCDs are cardiovascular diseases, cancers, chronic

respiratory diseases and diabetes [2], which have accounted for 68% of the world's 38 million deaths in 2012 [3]. In Brazil, NCDs accounted for 68.3% of deaths in 2011, with cardiovascular diseases (30.4%), cancers (16.4%) and diabetes mellitus (5.3%) being the most common [4].

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Diabetes mellitus (DM) has become a major public health problem whose prevalence rates increase with age. The number of adults affected by DM increased from 108 million in 1980 to 422 million in 2014, with 1.5 million deaths worldwide in 2012 [5]. In addition, projections suggest that the number of people affected by DM worldwide will rise to 592 million by 2035 [6,7].

In Brazil, a country where 27.2% of the population aged 65 years or older has diabetes, the estimated annual cost of diabetes is 2108 dollars per patient receiving outpatient care through Brazil's National Health System – the Unified Health System (*Sistema Único de Saúde – SUS*). Patients with microvascular and macrovascular complications represent higher costs (US\$ 3199), with most of the direct cost attributed to medication (48.2%) [8].

Considering that NCDs have common risk factors that characterize western lifestyle, such as sedentary lifestyle, stress, obesity and smoking, several countries have acknowledged the need to invest in primary prevention of diseases. France, for instance, implemented the National Health Nutrition Program (*Programme National Nutrition et Santé – PNNS*) to reduce overweight and obesity in adults and children [9]. Likewise, Brazil launched a program for the Surveillance of Risk and Protective Factors for Chronic Diseases through Telephone Survey (*Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico – VIGITEL*). VIGITEL is funded by the Secretariat of Health Surveillance to monitor the frequency and distribution of the main determinants of NCDs through telephone surveys [10].

Aging *per se* is associated with changes in individuals' body composition, increased fat mass and decreased lean mass due to decreased basal metabolism rate and physical activity, changes in appetite, decreased visual, olfactory and gustatory capacity, and swallowing disorders, thus leading to altered and lower nutrient intake [11]. These factors may contribute to the onset of eating disorders, which may result in obesity or malnutrition, which may be worsened by disability, social isolation, and mood disorders [12].

In addition, malnourished diabetic patients have longer hospitalizations: four days longer than patients who are not malnourished. Therefore, screening for malnutrition is important not only to correct malnutrition, but also to prevent the unnecessary use of drug therapy in the prophylaxis of episodes of hypoglycemia [13].

Given that, the present study aimed to screen the nutritional status of older adults with diabetes mellitus, seeking to outline the needs of this population group considering their socioeconomic status.

## 2. Methods

This is a quantitative analytical cross-sectional study of older adults (65 years old or older) with type 2 diabetes served by Brazil's National Health System, also known as the Unified Health System (*Sistema Único de Saúde – SUS*), in Northeastern Brazil. The research took place in the Integrated Center for Diabetes and Hypertension (*Centro Integrado de Diabetes e Hipertensão – CIDH*), a reference center for the care of and

research on diabetes and hypertension in the public health system.

Semi-structured questionnaires were used to collect sociodemographic data (age, gender, marital status, education, and income) and general health data (systemic diseases, use of medication, and deleterious habits (smoking and drinking), and the Mini Nutritional Assessment (MNA®) was used to assess nutritional status.

The Mini Nutritional Assessment (MNA®) was specifically designed to assess nutritional status in older adults. It can identify people at risk for malnutrition at an initial stage even before weight changes or alterations in serum protein levels occur as it includes the assessment of physical and mental aspects which often affect the nutritional status of older people [14].

The MNA assesses anthropometric measures (BMI, mid-arm circumference, calf circumference and weight loss), lifestyle, use of medication, mobility, neuropsychological problems, intake of water, fruits, vegetables and dairy products, autonomy in feeding, and self-rated health and nutritional status. The maximum score in the screening section is 14. A score of 12 or more indicates normal nutritional status. In case of scores below 12, the whole questionnaire should be answered.

The scores for the total assessment are as follows: 24–30 (normal nutritional status), 17–23.5 (at risk of malnutrition), and less than 17 (malnourished). The maximum score is 30. The questionnaire has a sensitivity of 96%, specificity of 98% and a predictive value of 97%. It is a rapid and simple questionnaire that can be completed in community or hospital settings [14].

The analysis of the body mass index, which was measured during nutritional assessment, was based on the classification proposed by Lipschitz [15], which is the most accepted for older adults. Thus, cutoff points were as follows: underweight  $\leq 22$  kg/m<sup>2</sup>, normal weight = 22–27 kg/m<sup>2</sup> and obesity  $\geq 27$  kg/m<sup>2</sup>. The method takes into account the changes in the body composition inherent to aging and uses equations to estimate weight and height of older adults who are unable to stand up for measurement [15].

The sample size was determined based on the total number of older adults in the city of Fortaleza in 2012 (N = 242.430) [16]. The minimum sample size to estimate a population proportion was determined considering a maximum expected proportion of 20%, a significance level of 5% (95% confidence interval) and a maximum permissible error of 5%.

The formula for finite population was used and the minimum sample size was estimated to be 246 older adults. A total of 1978 older people aged 65 years and older who have had diabetes for at least one year were enrolled in the CIDH. The medical records were selected according to their original reference number using convenience sampling. Inclusion criteria were: individuals with diabetes mellitus aged 65 years or older who agreed to participate in the research.

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 23.0 (SPSS Inc., Chicago, IL, USA) and tables were built using 2018 Microsoft Excel spreadsheets. Qualitative variables were described as

**Table 1 – Sociodemographic variables associated with older diabetic patients' nutritional status.**

Variables	Risk of malnutrition/ malnutrition (n = 48) n (%)	Normal nutritional status (n = 198)	PR (95%CI)	p value
<b>Age</b>				<b>&lt;0.001</b>
<80 years	27 (13.0)	181 (87.0)	1	
80 years or older	21 (55.3)	17 (44.7)	4.3 (2.7–6.7)	
<b>Gender</b>				0.319
Men	18 (16.7)	90 (83.3)	1	
Women	30 (21.7)	108 (78.3)	1.3 (0.8–2.2)	
<b>Race</b>				0.598 <sup>2</sup>
White	24 (21.6)	87 (78.4)	1.2 (0.7–2.1)	
Black	2 (25.0)	6 (75.0)	1.4 (0.4–5.1)	
Pardo (Mixed-race Brazilians)	22 (17.3)	105 (82.7)	1	
<b>Education</b>				<b>0.040<sup>1</sup></b>
None	12 (34.3)	23 (65.7)	5.8 (0.8–41.2)	
Primary education	31 (19.5)	128 (80.5)	3.3 (0.5–22.8)	
Secondary education	4 (11.4)	31 (88.6)	1.9 (0.2–16.1)	
Higher education	1 (5.9)	16 (94.1)	1	
<b>Income</b>				0.999
Up to 2 minimum wages	39 (19.5)	161 (80.5)	1	
2–5 minimum wages	7 (19.4)	29 (80.6)	1.0 (0.5–2.1)	
More than 5 minimum wages	2 (20.0)	8 (80.0)	1.0 (0.3–3.7)	

Source: Research data.  
<sup>1</sup> Chi-squared test.  
<sup>2</sup> Fisher's Exact Test.

absolute and relative frequencies and quantitative variables were described as means and standard deviations. Bivariate analyses were performed using the Chi-squared test or Fisher's Exact test. The significance threshold was set at 5%.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Research Ethics Committee of the University of Fortaleza (Approval No. 1.666.717). Written informed consent was obtained from all subjects/patients.

### 3. Results

Participants were 246 individuals aged 65–94 years, with a mean age of  $73 \pm 6.4$  years. There was a predominance of women (56.5%) and the mean duration of diabetes was 14.1 years ( $\pm 9.6$  years).

With regard to the MNA, 198 (80.5%) of the patients presented normal nutritional status, 39 (15.9%) were at risk of malnutrition, and nine (3.7%) were malnourished.

The mean BMI was  $28 \text{ kg/m}^2$ . According to the classification proposed by Lipschitz, 17 (6.9%) participants were underweight, 77 (31.3%) were at normal weight, and 149 (60.6%) were obese. Three people were unable to step on the scale for weight measurement due to motor problems. Therefore, their BMI could not be assessed. The analysis of the BMI and the mini-nutritional assessment revealed that 12 (70.6%) underweight patients were at risk of malnutrition or were malnourished. In addition, 18 (23.4%) patients at normal weight and 16 (10.7%) obese patients were at risk of malnutrition ( $p < 0.001$ ).

Table 1 shows the analysis of the association between nutritional status and age. The very old individuals (80 years or older) were 4.3 times more likely to be

**Table 2 – Anthropometric variables associated with older diabetic patients' nutritional status.**

Variables	Risk of malnutrition/malnutrition n (%)	Normal nutritional status	PR (95%CI)	p value
<b>BMI*</b>				<b>&lt;0.001</b>
Underweight	12 (70.6)	5 (29.4)	6.6 (3.8–11.5)	
Normal weight	18 (23.4)	59 (76.6)	2.2 (1.2–4)	
Obesity	16 (10.7)	133 (89.3)	1	

Source: Research data. Fisher's Exact Test.  
\* The BMI of 3 wheelchair users could not be measured.

**Table 3 – Comorbidities associated with older diabetic patients' nutritional status.**

Variables	Risk of malnutrition/malnutrition n (%)	Normal nutritional status	PR (95%CI)	p value
<b>Duration of diabetes</b>				0.890
1–10 years	25 (19.5)	103 (80.5)	1.1 (0.5–2.5)	
11–20 years	16 (20.8)	61 (79.2)	1.2 (0.6–2.7)	
More than 20 years	7 (17.1)	34 (82.9)	1	
<b>Dyslipidemia</b>				0.886
Yes	33 (19.8)	134 (80.2)	1 (0.6–1.8)	
No	15 (19)	64 (81)	1	
<b>Hypertension</b>				0.369
Yes	39 (18.6)	171 (81.4)	1	
No	9 (25)	27 (75)	1.3 (0.7–2.5)	
<b>Coronary artery disease</b>				0.010
Yes	22 (29.3)	53 (70.7)	1.9 (1.2–3.2)	
No	26 (15.2)	145 (84.8)	1	
<b>Heart failure</b>				0.055
Yes	10 (32.3)	21 (67.7)	1.8 (1–3.3)	
No	38 (17.7)	177 (82.3)	1	
<b>Stroke</b>				<0.001
Yes	14 (46.7)	16 (53.3)	3 (1.8–4.8)	
No	34 (15.7)	182 (84.3)	1	
<b>Obliterative arterial disease of the lower limbs</b>				0.165
Yes	7 (30.4)	16 (69.6)	1.7 (0.8–3.3)	
No	41 (18.4)	182 (81.6)	1	
<b>Peripheral neuropathy (abnormalities in the monofilament test)</b>				0.344
Yes	22 (22.4)	76 (77.6)	1.3 (0.8–2.1)	
No	26 (17.6)	122 (82.4)	1	

Source: Research data. Chi-squared test.

malnourished than those aged less than 80 years ( $p < 0.001$ ). In addition, uneducated individuals were 5.8 times more likely to be malnourished than individuals

with higher education ( $p = 0.040$ ). There were no significant associations of nutritional status with gender, race and income.

**Table 4 – Complication associated with older diabetic patients' nutritional status.**

Variables	Risk of malnutrition/malnutrition n (%)	Normal nutritional status	PR (95%CI)	p value
<b>Hypoglycemia in the past 6 months</b>				0.737 <sup>1</sup>
Yes	11 (21.2)	41 (78.8)	1.1 (0.6–2.0)	
No	37 (19.1)	157 (80.9)	1	
<b>Ketosis in the past 6 months</b>				0.333 <sup>2</sup>
Yes	2 (33.3)	4 (66.7)	1.7 (0.5–5.6)	
No	46 (19.2)	194 (80.8)	1	
<b>Hyperosmolarity in the past 6 months</b>				0.223 <sup>2</sup>
Yes	6 (31.6)	13 (68.4)	1.7 (0.8–3.5)	
No	42 (18.5)	185 (81.5)	1	
<b>Infection in the past 6 months</b>				0.017 <sup>1</sup>
Yes	14 (32.6)	29 (67.4)	1.9 (1.1–3.3)	
No	34 (16.7)	169 (83.3)	1	
<b>Current foot injury</b>				0.028 <sup>1</sup>
Yes	9 (36)	16 (64)	2 (1.1–3.7)	
No	39 (17.6)	182 (82.4)	1	

Source: Research data.

<sup>1</sup> Chi-squared test.

<sup>2</sup> Fisher's exact test.

Table 2 depicts the analysis of the association between nutritional risk and anthropometric measures. Older adults with normal body mass index (BMI), i.e., BMI between 22–27 kg/m<sup>2</sup>, exhibited a 2.2-fold higher risk for malnutrition than overweight or obese patients ( $p < 0.001$ ).

Table 3 shows a significant association of nutritional status with coronary artery disease ( $p = 0.010$ ) and stroke ( $p < 0.001$ ). Patients with heart failure present a 1.9-fold higher risk for malnutrition, and patients with stroke exhibit a 3-fold higher risk for malnutrition.

Table 4 shows that malnourished diabetic patients were 1.9 times more likely to report infectious episodes over the past six months ( $p = 0.017$ ) and two times more likely to present foot injuries ( $p = 0.028$ ) than well-nourished patients.

#### 4. Discussion

Studies have shown that diabetes mellitus and old age are two factors associated with an increased risk of malnutrition. Diabetes-related malnutrition can be caused by poor dietary intake or malabsorption, which can lead to deficiency of protein, energy and other nutrients, affecting several organs and systems and being responsible for alterations in the digestive, immune and muscular functions. As a result, there is an increased risk of morbidity and mortality and increased healthcare costs due to the lengthening of hospital stay [13,17].

Likewise, the findings of the present study demonstrated a higher prevalence of malnutrition in very old individuals, a finding that is also supported by studies that have reported higher prevalence rates of malnutrition in patients aged 70 years or older [13,18,19].

Risk of malnutrition was predominant in older diabetic women, but the correlation between nutritional status and gender was not significant. This finding is consistent with the findings of other studies [13,18]. It was the eighth leading cause of death among both sexes and the fifth leading cause of death in women [3].

The strong association between diabetes mellitus and education ( $p = 0.040$ ) and the 5.8-fold higher prevalence ratio for risk of malnutrition in uneducated older patients confirm that diabetes prevalence rate in Brazil is nearly three times higher among people with lower levels of education [10]. The influence of low levels of education is related to the fact that each person with diabetes needs individualized treatment prepared by a medical team (physician, nutritionist, nurses, and health educator [20]. In addition, low levels of education may hinder understanding of recommendations and prescriptions.

It should be noted that the mean MNA screening score was 12 points ( $\pm 2$  points). However, 48 (19.5%) older adults scored less than 12 points; therefore, it was necessary to proceed with the overall assessment, which revealed that 39 (15.9%) participants were at risk of malnutrition and nine (3.7%) were malnourished.

As a consequence, malnourished diabetic patients are more likely to have complications – whether infectious or not. In this regard, the findings of the present study show a significant association between malnourished diabetic older

adults and infections; these patients were 1.9 times more likely to present infectious episodes when compared with those with normal nutritional status ( $p = 0.017$ ).

The GERODIAB study carried out in France found 27.2% of diabetic patients with malnutrition after application of the MNA [21]. Regarding the BMI assessment in the GERODIAB study, the participants presented a mean BMI of 30 kg/m<sup>2</sup> [22], a value that is close to that found in the present study (mean BMI of 28 kg/m<sup>2</sup>).

However, some studies have shown that applying the BMI thresholds alone is not enough to assess the nutritional status of the older population as it overestimates the prevalence of overweight and obesity [23]. Older adults usually present changes in their body composition, such as decreased height, excess accumulation of adipose tissue, decreased amount of water in the organism and decreased lean mass in addition to decreased physical performance. Therefore, the BMI is not the most suitable method to assess anthropometric indicators in this population [24]. Sarcopenia, a common clinical condition in older adults and a complex syndrome involving progressive loss of muscle mass and function, is commonly associated with the risk of malnutrition or malnutrition [25].

In addition, BMI is strongly associated with increased relative risk of cardiovascular diseases, dyslipidemia, type 2 diabetes mellitus, and hypertension in young and middle-aged populations; however, this association is attenuated in old and very old populations [26].

In the present study, although the mean BMI was 28 kg/m<sup>2</sup>, 19.5% of the participants scored less than 12 points in the MNA and were hence considered malnourished. In a study carried out with older diabetic patients in China, 37.1% of the patients were overweight (BMI between 24 and 28 kg/m<sup>2</sup>) and 26.1% were obese (BMI > 28 kg/m<sup>2</sup>). After assessing the patients through the MNA, 14.1% of them were found to be malnourished and 42.6% were at risk of malnutrition [27]. These results demonstrate that older diabetic patients may present nutrient deficiencies even when they are overweight or obese, which is mostly associated with their inadequate diet. Therefore, adequate nutritional assessment should be carried out when assessing older diabetic patients, mainly because malnutrition is significantly associated with a 2.9-fold increase in mortality risk [27].

Corroborating these findings, a study conducted in Brazil to compare older diabetic and non-diabetic patients using the MNA showed that there is a higher prevalence of malnutrition in diabetic patients (58%) than in non-diabetic patients (22%) [28]. However, there was no significant association between the BMI and the nutritional status of the patients, and the high prevalence of comorbidities is due to decreased food intake, psychological stress or acute and neuropsychological diseases.

Research has reported that three in four adults with diabetes are overweight and approximately half of diabetic adults are obese [29]. Abdominal obesity, which is measured using abdominal circumference measurements, is more associated with metabolic disorders and higher cardiovascular risk when greater than or equal to 80 cm for women and 94 cm for men [30]. This measure can provide estimates of centralized fat mass that reflect the amount of visceral

adipose tissue, which increases the risk of type 2 diabetes mellitus by 10 times [31].

A study carried out in 35 hospitals in Spain assessed 1090 older diabetic patients, of whom 21.2% were malnourished and 39.1% were at risk of malnutrition according to the MNA scores [18]. This finding corroborates the fact that older adults tend to lose lean mass and accumulate body fat simultaneously, which makes it difficult to detect body changes in case of malnutrition [32]. Likewise, malnutrition exacerbates underlying diseases, contributes to bad outcomes and increases treatment cost; in addition, it is considered a predictor of mortality. In this context, MNA is considered the best tool for detecting the presence or risk of malnutrition in the older population [33].

The findings of the present study demonstrated that patients with coronary artery disease present a 1.9-fold higher prevalence of malnutrition and patients with heart failure exhibit a 1.8-fold higher prevalence of malnutrition; however, the association between heart failure and malnutrition was not significant ( $p = 0.055$ ). Nevertheless, this marginal value allows to speculate about a potential association, which is line with studies that emphasize that patients with heart disease are more prone to malnutrition due to reasons inherent to the disease, such as heart failure, anorexia, cardiac cachexia, among others.

Malnutrition in heart failure is associated with loss of muscle, fat and bone mass due to decreased intake, increased nutrient loss, increased metabolic rate and cytokine dysfunction involving tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ), cortisol, epinephrine, renin and aldosterone. In addition, malnutrition worsens symptoms and prognosis [34].

This fact is also demonstrated by studies reporting that malnourished patients with heart failure tend to be frailer [35]. Similarly, a study that assessed the nutritional status of patients with heart disease found that 69.6% of them had malnutrition, demonstrating that heart condition is a risk factor for poor nutritional status [36].

The present study found a statistically significant relationship between stroke and malnutrition ( $p < 0.001$ ) – patients with previous stroke presented a three times higher probability of malnutrition. Researchers have found that 5% of the patients admitted to a hospital after a stroke were malnourished and 14% were at risk of malnutrition [37]. This finding demonstrates the association between comorbidities and nutritional status. In this regard, prevalence rates of malnutrition among hospitalized patients with stroke ranging 6 to 65% have been reported [38], and overweight has been reported as a risk factor for stroke [39].

Older adults constitute a vulnerable population due to changes in body composition, decline in functions and senses, geriatric syndromes, difficulties in locomotion and associated clinical conditions. A large part of the older population is affected by malnutrition, particularly protein-energy malnutrition, which consists of an insufficient intake and/or excess consumption [40]. In older patients with diabetes the prognosis is even worse. This is due to the occurrence of a vicious circle in which one condition worsens the other. In addition, diabetic patients are at increased risk of malnutrition due to inappropriate diet and unassisted weight loss.

It should be noted that the present study analyzed patients admitted to one single specialized medical service; therefore, the results cannot be extrapolated to other patient groups. Nevertheless, because the service where the present research took place is a reference center for the treatment and control of diabetes, the results may also be found in other patient groups. Further research in this area is needed.

Despite this limitation, the present study reports important data on the association between diabetes and nutritional status in older adults and its consequences.

The MNA is a validated tool to identify geriatric patients aged 65 and above who are malnourished or at risk of malnutrition [14]. It is a screening method; therefore, it is necessary to refer people with risk of malnutrition or malnourished to nutritional services for specific assessment.

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## 5. Conclusion

Older diabetic patients with malnutrition were predominantly women, very old, and had low levels of education. Older patients with diabetes who were uneducated, aged 80 and older, and with BMI above or equal to 27 kg/m<sup>2</sup> were at an increased risk of malnutrition. Nutritional status was also significantly associated with coronary artery disease and stroke. In addition, older diabetic patients with malnutrition were more likely to have experienced infectious episodes in the past six months and more likely to present foot injuries than their well-nourished peers. Finally, malnutrition in older diabetic patients exacerbates underlying diseases, contributes to unfavorable prognosis, and increases treatment costs and mortality. Therefore, evidence-based health promotion and disease prevention strategies should be implemented to reduce the risk of malnutrition and its consequences in the older population.

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## 6. Statement of ethics

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Research Ethics Committee of the University of Fortaleza (Approval No. 1.666.717). Written informed consent was obtained from all subjects/patients.

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## Author contributions

**Designing the study:** Maria Vieira de Lima Saintrain, Rafaela Lais e Silva Pesenti Sandrin, Carina Bandeira Bezerra and Jean Doucet;

**Carrying out the study:** Rafaela Lais e Silva Pesenti Sandrin, Carina Bandeira Bezerra, Ana Ofélia Portela Lima, Marina Arrais Nobre and Débora Rosana Alves Braga;

**Analysing the data:** Maria Vieira de Lima Saintrain, Rafaela Lais e Silva Pesenti Sandrin, Carina Bandeira Bezerra and Débora Rosana Alves Braga.

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### Declaration of Competing Interest

The authors have no conflicts of interest to declare.

### Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.diabres.2019.107819>.

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